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a division of
AIKEN INDUSTRIES, INC.

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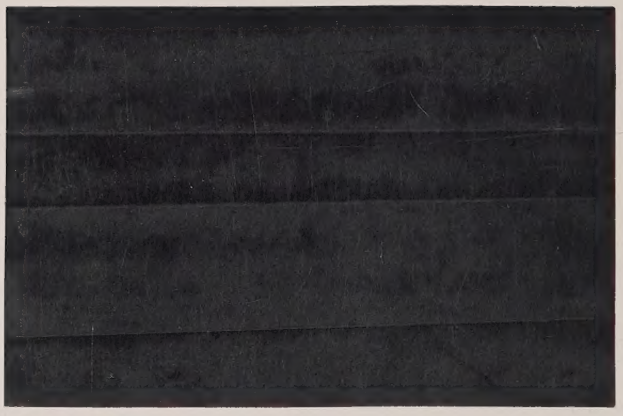
CIMRON®

MODEL DMM 42
DIGITAL MULTIMETER

A505

MP MASTER
MA28083



CALIFORNIA INSTRUMENTS
a division of
AIKEN INDUSTRIES, INC.

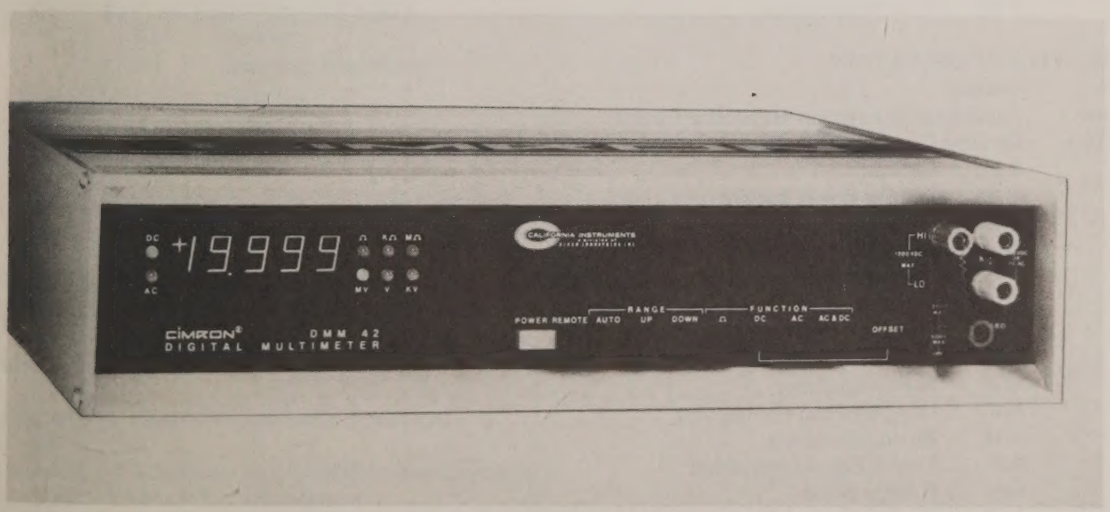
Revision B
February, 1976

INSTRUCTION MANUAL

CIMRON®

MODEL DMM 42
DIGITAL MULTIMETER

VIKING LABORATORIES INC.



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MANUAL CHANGE

MANUAL AFFECTED: DMM 42

REVISION LETTER: A

CHANGE NUMBER: A1

CHANGE DATE: 11/11/75

SERIAL NO EFFECTIVITY: Any

Additional Interface Information

1. Add to Paragraph 2-22: Note! If a false range/function is manually programmed, the Data Gate will cease. An example would be range 7 and DC.

2. Add to Paragraph 2-24: The range printed out is in ohms or mv with the range as an exponent. Example: Range 4 is 1×10^4 ohms or 10K ohms when in ohms function and is 1×10^4 mv or 10V when in AC or DC.

3. Add to Paragraph 2-27: To use the circuit shown in Figure 2-3, an insulated jumper must be installed from Pad 58 to Pad 59 on the Main Board.

4. Add new Paragraph 2-28: While under external start control and in AC or meg ohms, the settling delay timer must be externally started if repeat readings in a range are to be accurate. This is accomplished by installing an insulated jumper from Pad 60 to Pad 62 on the Main Board and applying a low from a relay contact or open collector transistor to A1J6, Pin 22. The falling edge of this signal should be coincident (± 1 ms) with the rising edge of the $\overline{\text{Hold}}$ signal. The duration may be anywhere from 10μs to 100 ms.

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SECTION I
DESCRIPTION

1-1 INTRODUCTION

1-2 This manual contains physical and functional descriptions, principles of operation, operating and maintenance instructions (including component location and schematic diagrams) and lists of replaceable parts for the CIMRON® Model DMM-42 Digital Multimeter, manufactured by CALIFORNIA INSTRUMENTS COMPANY, a division of AIKEN INDUSTRIES, INC. A photograph of the complete Digital Multimeter is shown on the frontispiece.

1-3 FUNCTION

1-4 The CIMRON® Model DMM-42 is basically a solid state, semi wireless DC Voltmeter with autoranging that, with optional plug in converters, can also measure AC volts (on an averaging basis but with RMS calibration) and resistances over a wide range of values. A true RMS AC Converter, not described in this manual, is also available and plugs into the same connectors as the averaging AC Converter. The use of a Dual-Quad Analog to Digital Converter and a four and one-half digit display results in extremely accurate readings of high resolution.

1-5 PHYSICAL DESCRIPTION

1-6 The DMM-42 Digital Multimeter is designed for bench use and, with Option 10 installed, may be rack mounted as well. All controls are front panel mounted. A rear panel connector is provided with appropriate connections to the internal circuits so the unit may be controlled manually or automatically from a remote point. The same connector provides access to the developed data, in binary coded decimal form, for use as an input to a computer or other peripheral device. Input terminals are front panel mounted. Two are provided for HI and LO input connections for DC and AC voltages. Two separate terminals are provided for the output of the OHMS Converter constant current source. The fifth terminal connects to the guard shield of the analog section of the unit so it may be separately driven. The front panel push button switches are labeled POWER, REMOTE, AUTO, UP, DOWN, Ω, DC, AC and AC/DC. The Ω, DC, AC and AC/DC switches are interlocked and only one may be depressed at any time. Front panel LED annunciators are activated to correspond to the appropriate push button functions selected and to indicate the units of measurement. The measured voltage or resistance is displayed on a four and one-half digit indicator comprised of seven-segment, gas discharge elements 0.55" in height. Rubber feet at each corner of the instrument elevate it 1/2 inch above the supporting surface. When the retractable bail, attached to the undersurface of the unit, is extended, the longitudinal centerline is at a 15° angle to the supporting surface. The instrument measures 3.5 inches in height, 15 inches in width and 12.25 inches in depth. None of the controls or connectors extend beyond the housing and are, therefore, well protected against accidental damage. The rear panel is recessed and formed of an aluminum extrusion that also functions as a convenient and comfortable carrying handle.

1-7 OPTIONS

1-8 A number of optional items are available to extend the capability of the basic DMM-42. These are listed in Table 1-1 on the following page.

1-9 This manual contains service information for the basic unit, the averaging AC Converter, (Option 01) and the OHMS Converter (Option 03). The True RMS AC Converter (Option 02) is furnished with installation instructions and service information.

1-10 SPECIFICATIONS AND PERFORMANCE DATA

1-11 Specifications and performance data for the Model DMM-42 Digital Multimeter are listed in Table 1-2. All units are factory tested to these specifications in accordance with standard California Instruments Company test procedures as detailed in Section V of this manual.

Table 1-1. Optional Equipment List.

ACCESSORY	OPTION NO.
Average Responding AC Converter	01
True RMS AC Converter	02
OHMS Converter	03
DC Current Shunts	04
High Voltage Probe	05
Analog Output	06*
Remote Command Module	07
Foot Switch for Remote Command Module	08
Rear Input-Parallel to Front	09*
Rack Mount Adapter	10
Signal Input Cable	11
Resistance Input Cable (Required with Option 11 for 4 wire ohms measurements)	12
Resistance Input Cable with Kelvin Clips (For use with 4 wire low Ohms measurements)	13
Mating Connector for Data Output and Remote Control Plug	14

*Factory installed only

Table 1-2. Specifications and Performance Data

PARAMETER	SPECIFICATION/PERFORMANCE
DC VOLTAGE MEASUREMENT	
Ranges	20 mv, 200 mv, 2V, 20V, 200V and 1200V.
Accuracy*	
20 mv Range	±(0.01% of Reading +0.015% of Full Scale)
Other Ranges	±(0.01% of Reading +0.005% of Full Scale)
Temperature Coefficient	
20 mv Range	±(0.002% of Reading +0.001% of Full Scale) Per ^{o}C
Other Ranges	±(0.001% of Reading +0.001% of Full Scale) Per ^{o}C
Input Impedance	
20mv, 200mv, 2V Ranges	1000 Megohms
20V, 200V, 1200V Ranges	10 Megohms
Common Mode Rejection	110db DC to 60 Hz with 100 Ohm Unbalance
Normal Mode Rejection	60db at 60 Hz
Settling Time	50 ms to Specification
AC VOLTAGE MEASUREMENT (Averaging)	
Ranges	2V, 20V, 200V and 1100V. Input Volt-Hertz Product not to exceed 2×10^{7}
Accuracy*	
10 Hz to 50 Hz	±(0.2% of Reading +0.1% of Full Scale)
50 Hz to 20 KHz	±(0.08% of Reading +0.015% of Full Scale)
20 KHz to 50 KHz	±(0.15% of Reading +0.025% of Full Scale)
50 KHz to 100 KHz	±(0.43% of Reading +0.04% of Full Scale)
Temperature Coefficient	±(0.003% of Reading +0.002% of Full Scale) Per ^{o}C
Input Impedance	
Front Input	1 Megohm Shunted by less than 25 pf
Front and Rear Input	1 Megohm Shunted by less than 50 pf
Common Mode Rejection	80db, DC to 60 Hz, 100 ohm unbalance
Settling Time	500 ms to Specification
RESISTANCE MEASUREMENT	
Ranges	2, 20, 200, 2K, 20K, 200K,2M, 20M and 200MΩ
Test Current	10ma, 10ma, 1ma, 100 ua, 10 ua, 1 ua, 1 ua, 100na and 10 na.

*90 Days at 25^{o}C ±5^{o}C

Table 1-2. Specifications and Performance Data (Continued)

PARAMETER	SPECIFICATION/PERFORMANCE
Accuracy*	
2 Ohm Range	±(0.02% of Reading +0.015% of Full Scale)
20 Ohm thru 200K Ohm Ranges	±(0.02% of Reading +0.01% of Full Scale)
2M Ohm Range	±(0.05% of Reading +0.01% of Full Scale)
20M Ohm Range	±(0.2% of Reading +0.025% of Full Scale)
200M Ohm Range	±(0.9% of Reading +0.25% of Full Scale)
Temperature Coefficient	
2 Ohm Range	±(0.004% of Reading +0.001% of Full Scale) Per ^{O}C
20 Ohm thru 200K Ohm Ranges	±(0.003% of Reading +0.001% of Full Scale) Per ^{O}C
2M Ohm Range	±(0.005% of Reading +0.001% of Full Scale) Per ^{O}C
20M Ohm Range	±(0.006% of Reading +0.002% of Full Scale) Per ^{O}C
200M Ohm Range	±(0.08% of Reading +0.01% of Full Scale) Per ^{O}C
Settling Time	
2 Ohm thru 200K Ohm Ranges	75ms to Specification
2M Ohm Range	150ms to Specification
20M Ohm Range	1.5 sec. to Specification
200M Ohms Range	15 sec. to Specification
Open Circuit Voltage	5 volts maximum
Input Configuration	True Four-wire
Input Protection	200 VDC or Peak AC
GENERAL	
Input	Floating and Guarded with Guard Connection at Front Panel
Display	4½ Digit, 0.55" High, Planar, Gas Discharge
Resolution, All Functions	1 Part in 20,000
Overload Indication	Blinking Display
Maximum Input Voltage Without Damage	
DC	10,000% of Range not to exceed 1200V Continuous. 1200V any Range for 1 Minute
AC	1100 Volts RMS
OHMS	200 VDC or Peak AC

*90 Days at 25^{O}C ±5^{O}C

Table 1-2. Specifications and Performance Data (Continued)

PARAMETER	SPECIFICATION/PERFORMANCE
GENERAL (Continued)	
Conversion Rate	2.5 Per Second
Range Selection	Automatic or Manual, Local or Remote
Function Selection	Front Panel Pushbutton or Remote Ground Signal
Data Output	1-2-4-8 BCD. TTL Compatible, Positive Logic
Remote Control	Isolated Control Lines Provided for Range and Function Controls
Input Power	115/230 VRMS ± 10%, 50 to 440 Hz. 16 Watts Max.
Operating Temperature	0 to 55°C
Storage Temperature	–40° to +75°C
Humidity	0 to 80%, Non-Condensing at 25°C
Altitude	0 to 10,000 Feet Operating, 0 to 50,000 Feet Non-Operating
Size	3.5" High, 15" Wide, 12.25" Deep. (8.89 cm High, 38.1 cm Wide, 31.1 cm Deep)
Weight	13 Lbs Approx.

SECTION II
INSTALLATION

2-1 GENERAL

2-2 This section of the manual provides instructions for unpacking, inspection for in-shipment damage, pre-operational tests and mechanical installation of the Model DMM-42 Digital Multimeter.

WARNING

This equipment is powered by and generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with all input power connections, the high voltage supply or display modules. Verify that power supply voltages are discharged to safe levels after power turnoff before touching circuitry.

2-3 INITIAL INSPECTION IN CONTAINER

2-4 A visual inspection of the shipping container should be accomplished prior to acceptance from the carrier and if extensive damage to the shipping container is evident, a description of the damage should be noted on the carrier's receipt and signed by the carrier's agent.

2-5 UNPACKING

2-6 Each Model DMM-42 Digital Multimeter is shipped in a cardboard container with protective inner packing, according to best commercial standards, and can be unpacked using standard procedures. Do not destroy the packing containers until the unit has been inspected for possible damage in shipment.

2-7 INITIAL INSPECTION

2-8 Visually inspect the Digital Multimeter for obvious mechanical damage, dents, broken controls, front and rear terminals and front panel breakage. If any damage is evident, notify the carrier. Do not return an instrument to the factory without prior approval.

2-9 POWER REQUIREMENTS

2-10 The CIMRON® Model DMM-42 Digital Multimeter may be powered from a 48 to 420 Hz power line. The unit is normally set for operation from 105 to 125 volts RMS. Voltages above this limit may damage the instrument and voltages below this limit will result in below standard performance. The unit may also be operated from 210 to 250 volts RMS by resetting the power selector switch, A1S1, located adjacent to the power transformer, A1T1, on the main circuit board at the left rear. The Multimeter requires approximately 15 watts from the AC line.

2-11 FUSE PROTECTION

2-12 The Digital Multimeter is protected by a single 3/8 ampere slo-blo fuse retained in a twist-out holder mounted in the rear panel of the instrument. A 2/10 ampere slo-blo fuse is used when the instrument is switched for 230 volt operation.

2-13 POWER INPUT WIRING

2-14 The Digital Multimeter is supplied with a conventional three pronged power input plug on the end of a six-foot cable and is used with 115 volt AC lines with a capacity of 1 ampere or greater. To operate the unit from a 230 volt source, it may be necessary to remove the plug and replace it with one compatible with the existing 230 volt receptacle.

2-15 PRELIMINARY CHECKS AND ADJUSTMENTS

2-16 Each Model DMM-42 Digital Multimeter is carefully inspected and adjusted at the factory and should not normally require adjustment at time of installation, however, the following checks should be performed to verify functional operation. A list of required test equipment will be found in Table 5-1.

A description of the location and function of all front panel controls is provided in paragraph 3-4 of this publication.

A. Connect the unit to the power source, turn on power by depressing the POWER switch and allow 30 minutes for warm up and stabilization.

B. Short the input leads, select the DC function by depressing the DC switch button, place the unit in manual operation by releasing the AUTO switch, if depressed, and select the 2 volt range by pressing the UP or DOWN switch until the appropriate range annunciator and decimal locations are illuminated. If the display does not read 0.0000, select the 20mv range and adjust the OFFSET for a reading of 00.000. Return the unit to the 2 volt range and check for a reading of 0.0000.

C. Using a Cohu Model 351, or equivalent DC Standard, apply +1.0000 volt to the input of the instrument. The display should indicate +1.0000 ±2 digits.

D. If the AC Converter is installed, select the AC function by depressing the AC switch button and select the 2 volt range. Using a Hewlett Packard Model 745, or equivalent AC calibrator, apply 1.0000 volts RMS at 1 KHz to the input terminals. The display should read 1.0000 ±13 digits.

E. If the OHMS Converter is installed, select the OHMS function by depressing the Ω switch button and select the 2K range. Connect a 1K Ohm ±0.005% resistor to the input as shown on the diagram at the input terminals. The display should read 1.0000 ±4 digits.

Failure of the unit to operate within the limits set forth above, indicates the need for adjustment of the unit in accordance with calibration procedures detailed in Section V of this manual.

2-17 MECHANICAL INSTALLATION

2-18 The CIMRON® Model DMM-42 Digital Multimeter is designed for bench or optional rack mounting. Bench mounting should present no installation problems. Rack mounting (Option 10) requires that adequate clearance be provided between the Model DMM-42 and other equipment and that a free flow of air be available to maintain the temperature of the surrounding air at or below +50°C. Heat will have an adverse effect on any item of electronic equipment and useful life will be prolonged if lower temperatures are maintained. A dimensioned outline drawing of the DMM-42 Digital Multimeter is shown in Fig. 2-1.

2-19 INPUT SIGNAL CONNECTIONS

2-20 Five terminals are provided on the front panel for connection to external voltages and resistances to be measured. For all AC and DC measurements, the input is connected to the INPUT HI and INPUT LO terminals. When measuring high resistances where the resistance of connecting leads is not of importance, the blue (–) terminal may be connected to the black (INPUT LO) terminal and the yellow (+) terminal connected to the red (INPUT HI) terminal with straps or short leads. The test leads are then connected to the red and black terminals. When low resistances are to be measured, the four wire system is used. A lead from the yellow (+) terminal is applied to the unknown resistance and a lead from the red (HI INPUT) terminal is applied to the same point. Straps between these terminals are removed, of course. Likewise a lead from the blue (–) terminal is applied to the same point as the lead from the black (LO INPUT) terminal. Since the test current is not flowing in the leads connecting the resistors to the input of the voltmeter section of the instrument, the resistance of those leads will have no effect on the reading. Also, since the current flowing between the blue and yellow terminals is constant, irrespective of total circuit resistance, the voltage drop across the resistor will be a true measure of its resistance which will be measured by the voltmeter section of the instrument. Option 9 provides rear terminals connected in parallel with those of the same color on the front panel and the connections to external signals and resistances are made in the same manner as those to the front panel terminals.

2-21 REMOTE CONTROL CONNECTIONS

2-22 Table 2-1 lists the connections to the rear panel remote control connector, A1J6. The control lines become operative when the front panel REMOTE switch is depressed. A ground on the $\overline{\Omega}$, $\overline{\text{RMS UNBLOCK}}$, $\overline{\text{AC}}$ or $\overline{\text{HOLD}}$ lines will then energize that function. Likewise, the range may be manually selected from the remote location by grounding $\overline{\text{MAN}}$ and the appropriate lines labeled $\overline{1}$, $\overline{2}$, $\overline{4}$, and $\overline{8}$ for the BCD code appropriate

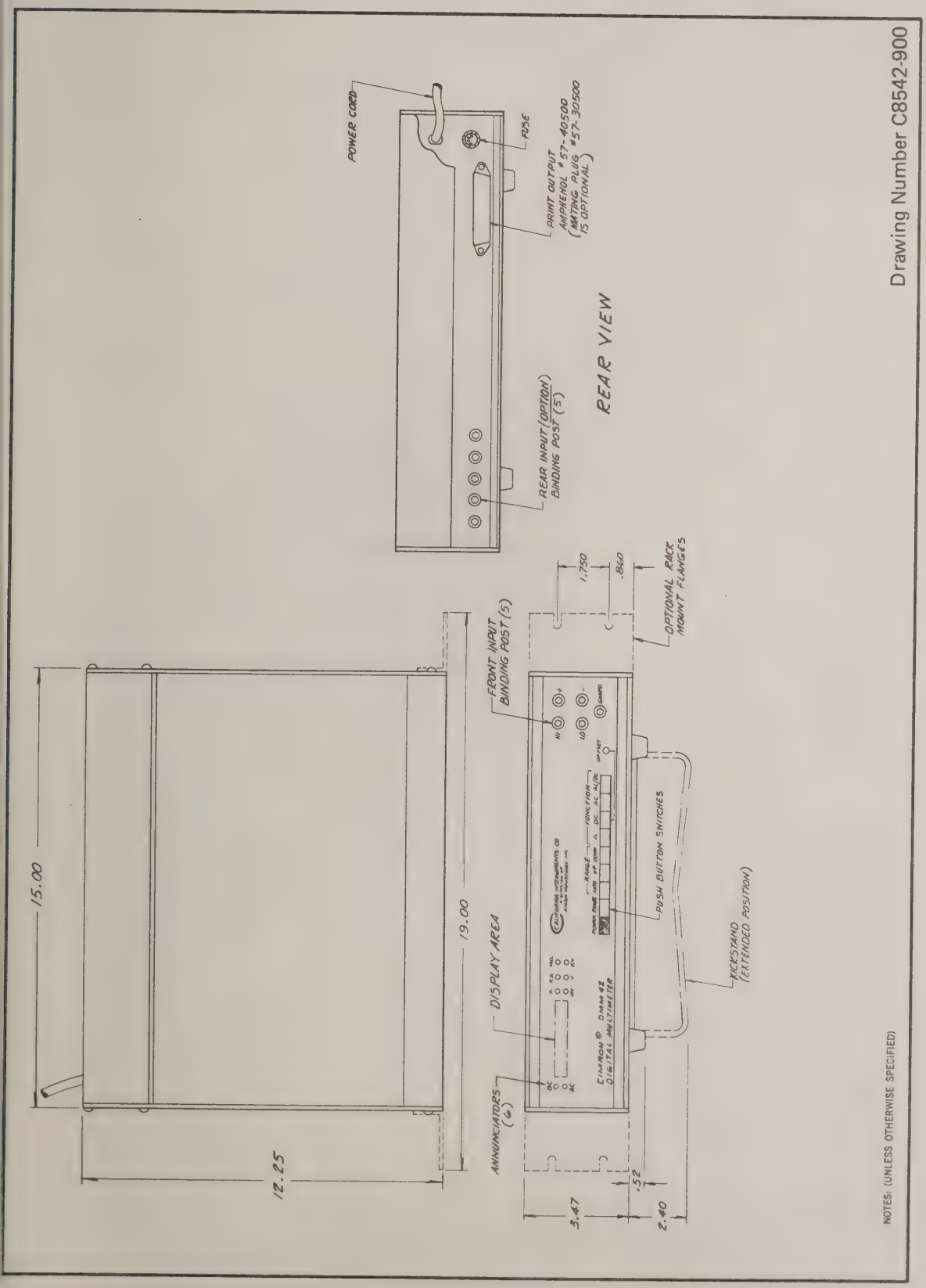


Figure 2-1. Outline Dimensions, Model DMM-42 Digital Multimeter.

Table 2-1. Connector A1J6 Connections

	PIN NO.	FUNCTION
CONTROL INPUTS	26	$\overline{\text{Manual Range}}$
	9	$\overline{1}$ Range Program
	10	$\overline{2}$ Range Program
	7	$\overline{4}$ Range Program
	6	$\overline{8}$ Range Program
	2	$\overline{\Omega}$ Function Program
	3	$\overline{\text{AC}}$ Function Program
	1	$\overline{\text{RMS UNBLOCK}}$
DATA OUTPUTS	19	Data Ready
	46	$\overline{\text{Hold}}$ (Printer Busy)
	4	Ω Function
	5	AC Function
	47	AC & DC Function
	20	+POL
	27	Overload
	28	10K-1
	30	1K-1
	29	1K-2
	32	1K-4
	31	1K-8
	33	100-1
	34	100-2
	35	100-4
	36	100-8
	38	10-1
	37	10-2
	39	10-4
	40	10-8
	42	1-1
	41	1-2
	43	1-4
	44	1-8
	14	1 (Range)
	12	2 (Range)
	13	4 (Range)
	11	8 (Range)
	45	$\overline{\text{Remote Flag}}$
	49 and 50	Common

o the range state desired. Ranging, both automatic and nanual, is covered in detail in Section IV paragraphs -69 through 4-98. A remote control must be designed vith consideration to the limits of range and range states sed in each mode of operation as shown in Table 4-1, he relay matrix of Table 4-2 and to compatibility with TL logic circuits. All inputs must sink 3 ma or greater. in locations for the mating connector to A1J6 are nown in Fig. 2-2.

READY will not go to a high state until the autoranging system has brought the instrument to the proper range for the applied input to the front panel (or rear panel) connectors. In the event the input is beyond the range of the instrument, the DATA READY line will go high. In the manual mode of operation, the DATA READY line will be high immediately after the reading has been made although it may not be in the correct range. All outputs will drive two normal TTL loads.

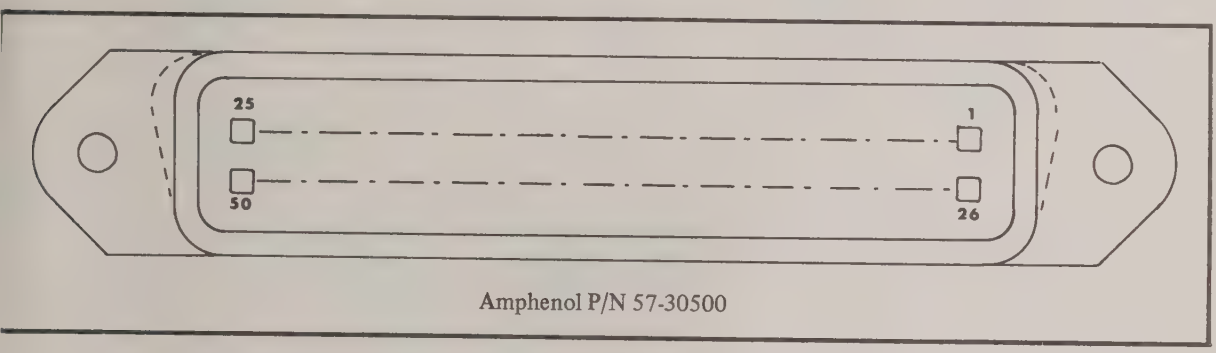


Figure 2-2. Mating Connector to A1J6 Terminal Locations (viewed from rear)

23 REMOTE MONITORING, DIGITAL

24 The data generated by the DMM-42 Digital Multi- eter may be monitored remotely, although special uipment is required. Data in BCD code for each dis- ay digit is available at A1J6 as shown in Table 2-1. ese are buffered outputs compatible with TTL digital gic and the logic is positive. This data is available on rminals 27 through 44. In addition, +POL, and DATA EADY outputs are brought to terminals 20 and 19 spectively. +POL will be high when the DC input is sitive. It will be low when the DC input is negative d on all ranges of AC and resistance. DATA READY ll be high when the instrument displays the input volt- e reading. If the instrument is in autorange, DATA

2-25 REMOTE MONITORING, ANALOG

2-26 Remote analog monitoring is an optional function that requires an additional circuit board. Provisions have been made on the main circuit board for the installation of a connector for a plug-in circuit board for this function but is not installed without the option. Full directions for use of the analog monitoring function are provided with the option at time of shipment.

2-27 To obtain first reading accuracy in the 20M and 200M ohm ranges, the external circuit shown in Fig. 2-3 is required. This circuit provides the additional settling time required in these ranges before the reading is taken. This circuit is not provided as an option but must be fabricated locally using components as shown.

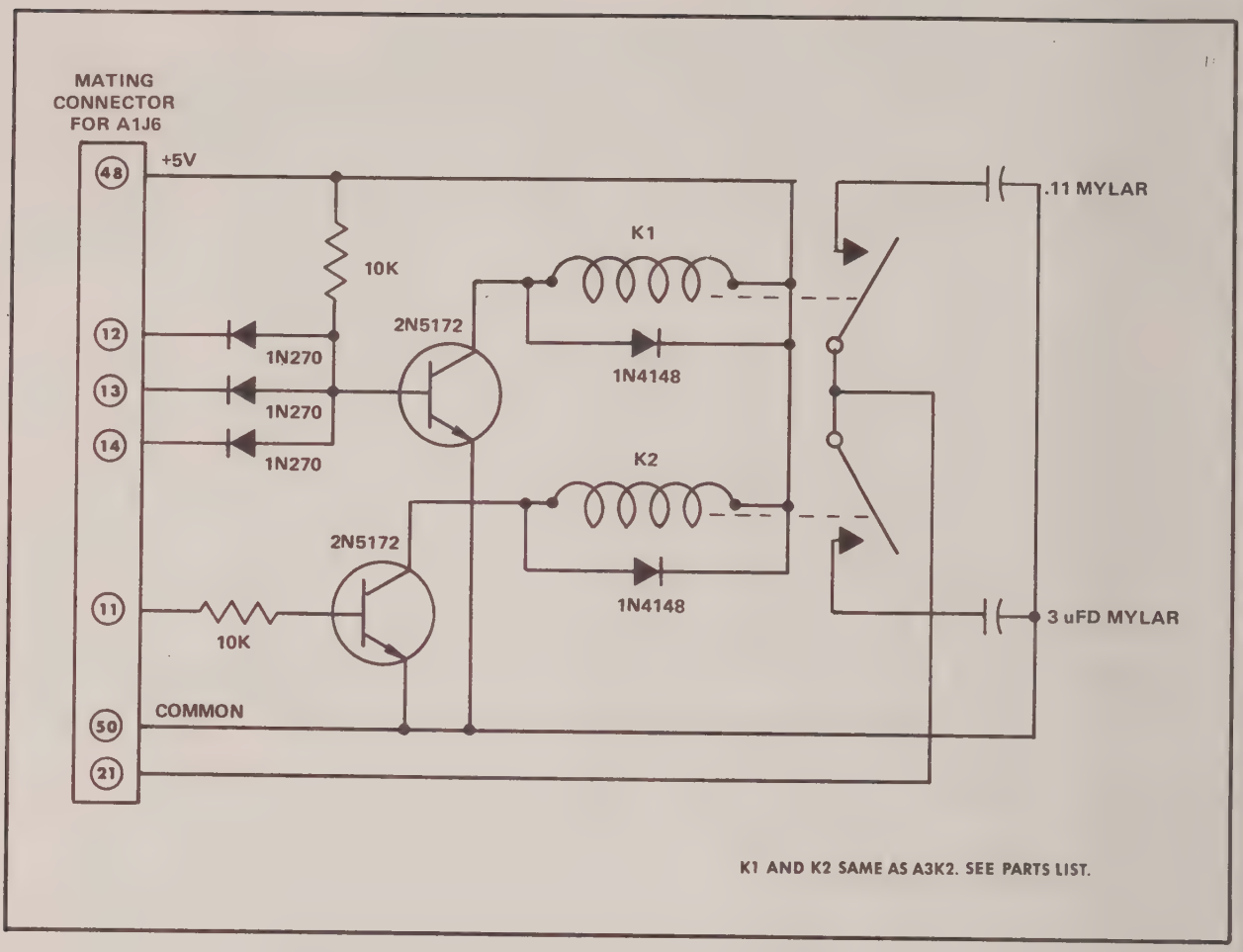


Figure 2-3. External 20M Ohm and 200M Ohm Settling Circuit

SECTION III
OPERATION

3-1 GENERAL

3-2 This section of the manual provides instructions for use and operation of each control and front panel adjustment, connections to external circuits and operation from remote locations.

3-3 FRONT PANEL OPERATING CONTROLS AND INDICATORS

3-4 The front panel operating controls and indicators are shown in Fig. 3-1 and described in Table 3-1.

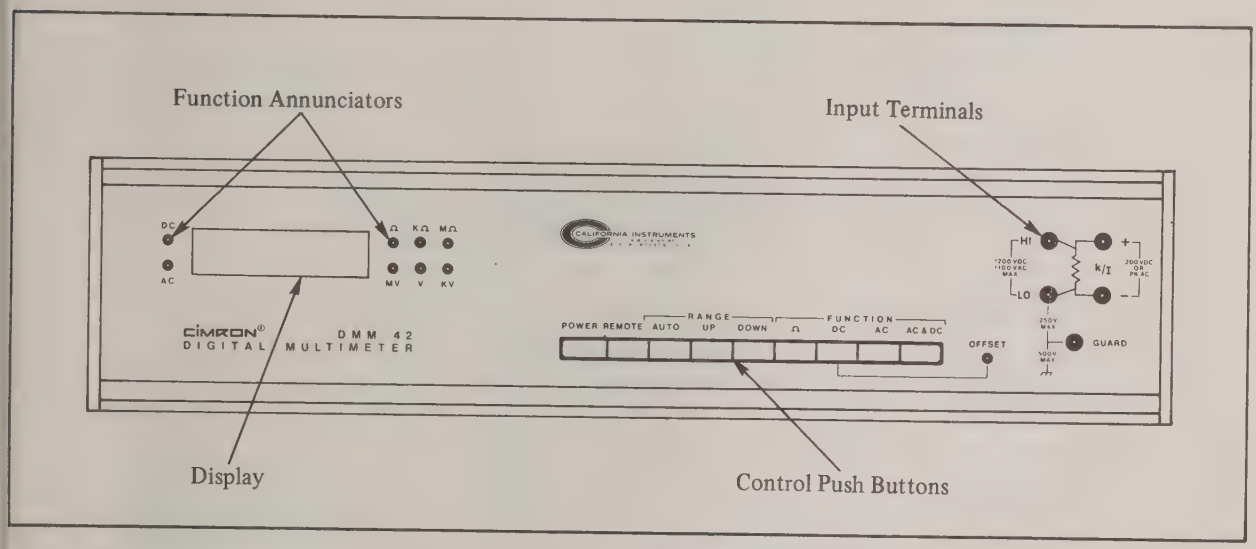


Figure 3-1. Control and Indicator Locations.

Table 3-1. Control and Indicator Functions.

CONTROL/ INDICATOR	POSITION	FUNCTION	LOCATION
POWER	PUSH FOR ON	The AC input power is connected to the instrument when the switch is pushed on. The display will light when power is applied.	Left button in row at bottom center of panel.
	PUSH FOR OFF	The AC input power is disconnected from the instrument when the button is extended. The display will be extinguished.	

Continued

Table 3-1. (Continued)

CONTROL/ INDICATOR	POSITION	FUNCTION	LOCATION
REMOTE	PUSH FOR REMOTE OPERATION	Transfers control function selection and autorange/manual range selection to rear panel connector A1J6. Front panel UP and DOWN controls remain operative.	Second button from left in row at bottom center of panel.
	PUSH FOR LOCAL OPERATION	Control is returned to front panel push button switches when button is extended.	
AUTO	PUSH FOR AUTORANGE CONTROL	Instrument is in autorange mode of operation when button is depressed. Unit will select proper range to display voltage applied to input terminals.	Third button from left in row at bottom center of panel.
	PUSH FOR MANUAL RANGE CONTROL	Instrument is in manual range control mode of operation when button is released.	
UP	PUSH TO UP RANGE DISPLAY	Button is spring loaded. Display will uprange at 2.5 times per second rate when button is depressed until upper range is reached.	Fourth button from left in row at bottom center of panel.
DOWN	PUSH TO DOWN RANGE DISPLAY	Button is spring loaded. Display will downrange at 2.5 times per second rate when button is depressed until lower range is reached.	Center button in row at bottom center of panel.
Ω	PUSH FOR OHMS MODE OF OPERATION	Instrument measures resistance when button is depressed and OHMS converter is installed. Button is interlocked and will release when another button is depressed.	Fourth button from right in row at bottom center of panel.
DC	PUSH FOR DC MODE OF OPERATION	Instrument measures DC Voltage when button is depressed. Button is interlocked and will release when another function button is depressed.	Third button from right in row at bottom center of panel.

Continued

Table 3-1. (Continued)

CONTROL/ INDICATOR	POSITION	FUNCTION	LOCATION
AC	PUSH FOR AC MODE OF OPERATION	Instrument measures AC Voltage when button is depressed and AC Converter is installed. Used with either type of AC Converter. Button is interlocked and will release when another function button is depressed.	Second button from right in row at bottom center of panel.
AC/DC	PUSH FOR AC/ DC MODE OF OPERATION	Instrument measures combined RMS value of AC voltage superimposed on DC voltage when button is depressed and True RMS converter is installed. Button is interlocked and will release when another function button is depressed.	Right button in row at bottom center of panel.
DISPLAY		Displays value of DC voltage, AC voltage or resistance connected to front panel or rear panel input connectors. Indicates + or – polarity in DC operational mode. Decimal points are placed in proper location with range changes.	Upper left of panel
AC ANNUNCIATOR		Illuminated when unit is in AC mode of operation.	Lower left corner of display.
DC ANNUNCIATOR		Illuminated when unit is in DC mode of operation	Upper left corner of display.
OHMS ANNUNCIATOR		Illuminated when unit is in OHMS mode of operation and in 2, 20 or 200 ohm range.	At right of display.
K OHMS ANNUNCIATOR		Illuminated when unit is in OHMS mode of operation and in 2K, 20K or 200K ohm range.	At right of display.
M OHM ANNUNCIATOR		Illuminated when unit is in OHMS mode of operation and in 2M ohm, 20M ohm or 200M ohm range.	At right of display.

(Continued)

Table 3-1. Continued.

CONTROL/ INDICATOR	POSITION	FUNCTION	LOCATION
MV AN-NUNCIATOR		Illuminated when unit is in DC mode of operation and in 20mv or 200mv range.	At right of display.
V AN-NUNCIATOR		Illuminated when unit is in DC or AC mode of operation and in 2V, 20V or 200V range.	At right of display.
KV AN-NUNCIATOR		Illuminated when unit is in DC or AC mode of operation and in 2KV range.	At right of display.
OFFSET	ADJUSTABLE	Provides adjustment to cancel out any offset due to thermal induced voltages between input terminals and input to buffer amplifier.	To right of pushbuttons.

3-5 INITIAL ADJUSTMENTS AND CONTROL SETTINGS

3-6 The CIMRON® Model DMM-42 Digital Multimeter has been adjusted at the factory and should not require special adjustments prior to operation except to set the OFFSET potentiometer for a 00.000 reading with the input terminals shorted, the unit in the DC mode of operation and on the 20mv range.

3-7 START UP PROCEDURE

3-8 Connect the instrument to a source of 115 VAC power (230 VAC if switch A1S1 is set at 230 V). Press the POWER switch, note that the display lights and wait 30 minutes for the instrument to stabilize.

3-9 AUTO/MANUAL RANGE SELECTION

3-10 In any of the modes of operation, autoranging or manual ranging may be selected. To select autorange, depress the AUTO switch button. To select a range manually, release the AUTO switch, if depressed, by depressing and releasing it. Then press the UP or DOWN switch until the desired range is reached as indicated by the annunciator lights and the location of the decimal point in the display. When in autorange and the input voltage or resistance is greater than that for which the instrument is designed (over range), the ranging system will step up to the highest range for the function selected and the display will then begin to blink at a 2.5 times per second rate. In the manual range selection mode, the display will blink whenever the input voltage or resistance being measured is greater than the selected range. Also, in autorange, the instrument may be manually down ranged one step if the reading is 1,999 or less, ignoring the decimal point, simply by depressing the DOWN switch button.

CAUTION

Immediately disconnect the input if the display continues to blink. Overvoltage can result in permanent damage to the instrument;

3-11 DC VOLTAGE MEASUREMENTS

3-12 Select automatic or manual range control as desired. Depress the DC switch button. Connect two leads from the INPUT HI and INPUT LO terminals to the circuit to be measured. Allow the instrument to settle, if in autorange, and read the measured voltage and its polarity directly from the display. If in the manual range control mode, it may be necessary to uprange or downrange the instrument to bring the selected range in concert with the measured voltage.

3-13 AC VOLTAGE MEASUREMENTS

3-14 Select automatic or manual range control as desired. Depress the AC switch button. Connect two leads from the INPUT HI and INPUT LO terminals to the circuit to be measured. Allow the instrument to settle, if in autorange, and read the measured voltage directly from the display. If in the manual range control mode, it may be necessary to uprange or downrange the instrument to bring the selected range in concert with the measured voltage.

3-15 AC/DC (RMS) MEASUREMENTS

3-16 This operating procedure is contained in the special instructions furnished with the RMS converter.

3-17 RESISTANCE MEASUREMENTS

3-18 TWO WIRE SYSTEM

3-19 Strap the yellow terminal to the red terminal and the blue terminal to the black terminal. (These connections do not need to be removed when making DC and AC measurements as the internal relays in the OHMS Converter disconnect the yellow and blue terminals when the instrument is in the DC or AC mode of operation.) Select autorange or manual range control as desired. Depress the OHMS switch button and connect two leads from the INPUT HI and INPUT LO terminals to the resistance to be measured. Allow the instrument to settle, if in autorange, and read the resistance directly from the display. If in the manual range control mode, it may be necessary to uprange or downrange the instrument to bring the selected range in concert with the measured resistance.

3-20 FOUR WIRE SYSTEM

3-21 An optional set of leads are available for the four wire resistance measuring system, (see Section I). In the four wire system, the constant current from the OHMS Converter is applied to the resistance to be measured through two independent leads. The input of the instrument is then connected across the resistor. Thus, only the voltage drop across the resistor is measured rather than that of the resistor and the leads connecting it to the instrument. This is of particular importance where the resistance under measurement is in the order of a few ohms or less. Figure 3-2 shows the connections between the instrument and the measured resistance.

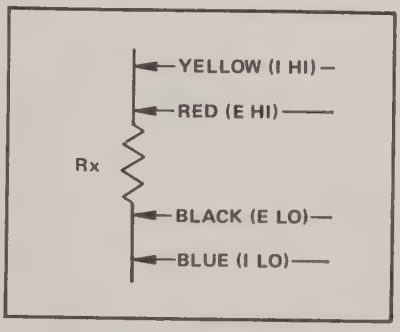


Figure 3-2. Four Wire Resistance Measurement.

SECTION IV
PRINCIPLES OF OPERATION

4-1 GENERAL

4-2 The CIMRON® DMM-42 Digital Multimeter is a precision device that measures DC voltage with high accuracy and resolution. An optional AC Converter attenuates the AC signal as necessary and applies a rectified output to the basic unit, or mainframe, for accurate measurement. The OHMS Converter pumps a precise current through the unknown resistance and applies the voltage generated across the resistance to the basic unit for measurement.

4-3 In the DC Operational Mode, the input is routed through a step attenuator and to the Dual Quad Analog to Digital Converter.

4-4 The instrument operates in 8 serial states of 50 milliseconds each. Reference Timing Diagram Fig. 4-2. In states 2 through 5, the auto zero function compensates for initial offsets and drift in the analog circuits. During states 6 and 7, the unknown voltage is integrated. During states 0 and 1, a precise reference voltage of opposite polarity is integrated to drive the integrator output back to zero. The time for the reference integration is a precise measurement of the unknown voltage and is measured by a crystal controlled digital clock thus accomplishing the analog to digital conversion.

4-5 The clock count is displayed on a four and one-half digit, high intensity, gas discharge display. An automatic ranging system selects the proper range, activates a red LED annunciator to indicate the range in use and illuminates the proper decimal point in the display. Manual ranging is also provided and automatically protected against selection of an improper range when switching from one operational mode to another. An input beyond the range of the instrument causes the display to blink at a 2.5 times per second rate.

4-6 FUNCTIONAL DESCRIPTION – MAINFRAME CIRCUITS

4-7 A block diagram of the DMM-42 Multimeter is shown in Fig. 4-1. The timing diagram, Fig. 4-2, shows the several timing signals basic to the operation of the instrument, the 8 operational states and the three operational periods. The sequence of measurement is:

A. Auto Zero (E_0)

B. Integrate the unknown (E_X).

C. Integrate the reference while counting the clock (E_R).

D. Display the clock count.

If the instrument is in autorange, steps A, B and C will be repeated until the clock count is within range.

4-8 During the E_0 period, the auto zero function compensates for all initial offsets and drift in the buffer, integrator and comparator. During the E_X period, the input voltage, amplified by the buffer, is integrated. The level to which the integrator output will rise during E_X is a linear function of the input voltage. During E_X, a polarity detector stores the polarity of the integrator output. At the end of E_X, the polarity detector directs switches which apply a precision reference voltage to the input of the integrator of a polarity that will drive the output of the integrator back toward zero. Whereas the slope of the integrator during E_X is dependent on the level of the input voltage, being steep for a high input and shallow for a low input, the constant 10 volt reference will produce a constant slope as shown in Timing Diagram Fig. 4-2. Therefore, the time to integrate the reference to zero is a precise measurement of the unknown input.

4-9 The comparator will detect the zero crossing of the integrator output and, through following logic circuits, stop the E_R period. During E_R, the logic circuits are counting the crystal controlled digital clock pulses and the number of counts is an accurate measurement of the input voltage. Switching, at the transition from E_X to E_R, can cause transients that could signal a false zero crossing. Therefore, the logic circuits are disabled for 0.5 milliseconds and this is the E_T period following E_X and shown on the timing diagram. The logic circuits do not start to count the clock until the end of E_T. As compensation, the zero reference is shifted precisely so that integration, which started at the end of E_X, will continue for an additional 0.5 milliseconds.

4-10 If the instrument is in autorange and the count exceeds 20,000 or is less than 1000, the ranging system

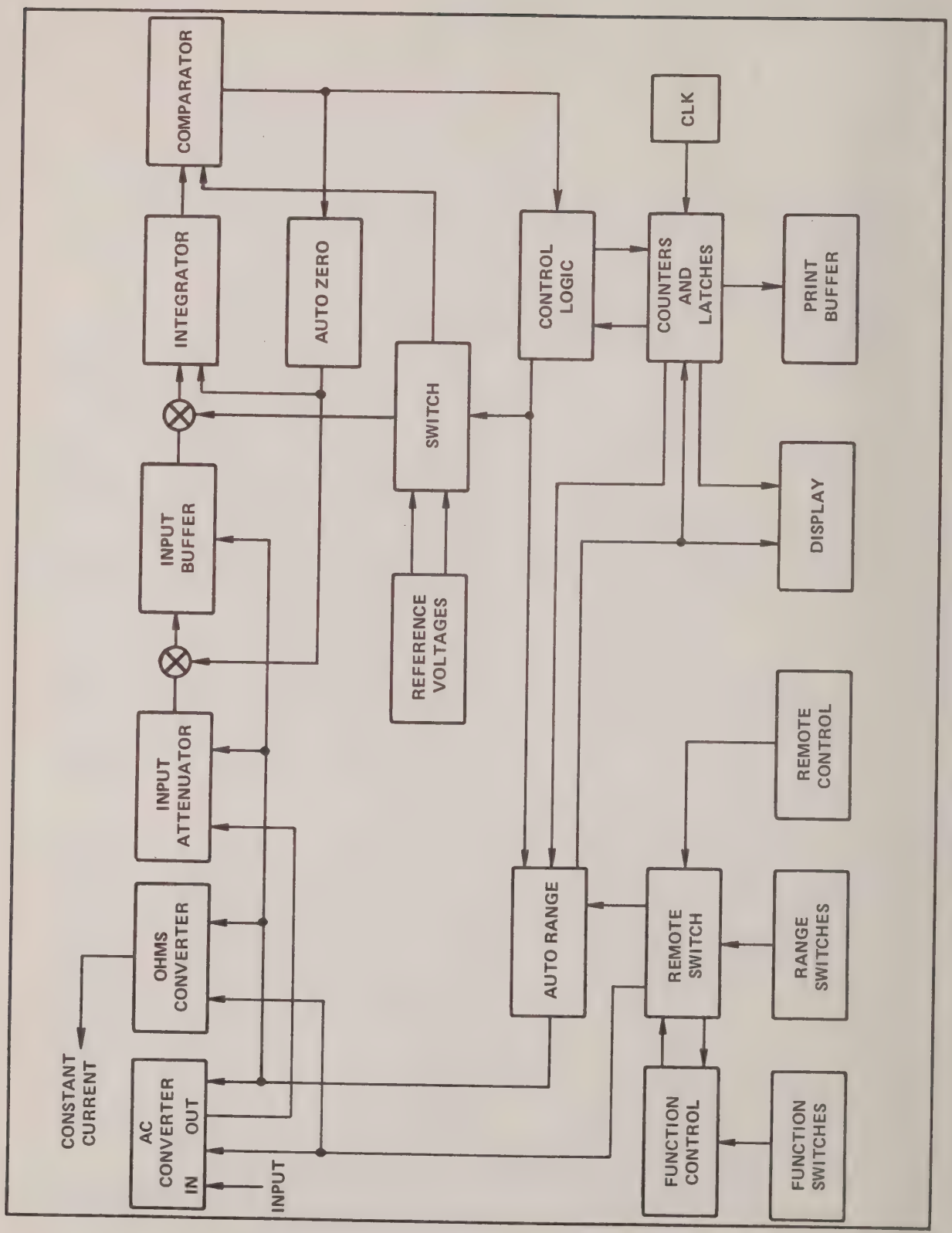


Figure 4-1. Block Diagram, Model DMM-42 Digital Multimeter.

will adjust the range by one step. The instrument will again integrate the unknown and the reference, repeating this sequence until the count is within range. If the input is so high that the ranging system cannot up range far enough to bring the count to less than 20,000, the display will blink at a 2.5 times per second rate.

4-11 In the manual range mode, the operator must up range the instrument if the display is blinking although it will continue to blink, as in autorange, if the input is beyond the range of the instrument.

4-12 Zero detection does not stop the digital clock but strobes the outputs of a string of counters, following the crystal oscillator, to the outputs of five quad latches which, in turn, are connected to BCD to seven segment decoder-drivers that control the seven segment display units. The clock continues to run to produce the timing signals and initiate a new sequence of measurement.

4-13 A single ranging system operates in the automatic and manual modes. There are nine range states, 0 through 8. DC measurements are restricted to states 1 through 6, AC measurements to states 3 through 6. Resistance measurements utilize all nine states. If the unit is switched from the OHMS mode of operation to AC or DC and it is in one of the range states not used for those measurements, it will be clocked into the nearest acceptable range state by a 200 KHz clock signal. The same is true when shifting from DC to AC operation. Table 4-2 shows which states are used for each mode of operation and for each range within that mode.

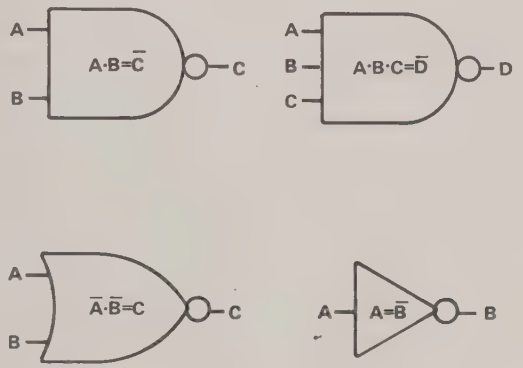
4-14 By controlling the input attenuation and the buffer amplifier gain, the ranging system insures that the output of the buffer amplifier is within the 0 to 2 volt range during measurements. This it accomplishes through a logic system that accepts range state and mode of operating inputs and then closes relays in the input circuit section to insert series and parallel resistors to achieve the required attenuation. Relay contacts in the buffer amplifier feedback loop, which adjust the feedback voltage and amplifier gain, are also operated by the ranging system as are attenuator and gain adjusting relays in the AC Converter and current adjusting relays in the OHMS Converter.

4-15 The analog and digital circuits are independently powered and isolated from each other so that the input terminals may be connected to potentials above or below the case potential without damage to the instrument provided the potential difference is limited to 500 volts. Signals are conducted between analog and digital circuits through photocouplers. The shield of the analog circuitry is guarded and connected to the GUARD terminal on the front panel. This is normally connected to the LO terminal but may be independently driven. The instrument is provided with output terminals at the rear of the case for remote control and for driving a recorder or computer input. Section II, Installation, details some of the requirements for making connections to these terminals.

4-16 DETAILED CIRCUIT DESCRIPTION

4-17 GENERAL

4-18 The schematic diagram for the main circuit board is in two parts, Figs. 6-3 and 6-4 and will be found in Section VI. The logic utilized in the DMM-42 is of the TTL family and is basically of the NAND and NOR type. A logic "0", or low, state is defined as between 0 volts and +.4 volts. A logic "1", or high, state is defined as between +2.4 volts and +5 volts. The truth table for this logic is as follows:



4-19 There are a number of power sources and voltage regulators in the instrument to provide the several different voltages required and to isolate the analog and digital circuitry. All power is derived from the line through a single power transformer, A1T1, which is mounted directly to the printed circuit board, A1. The input to this transformer is protected by F1 located at the rear of the chassis. Power input may be 115 VAC or 230 VAC as determined by the position of switch A1S1 located on circuit board A1 adjacent to the power transformer. A1T1 and A1S1 are shown in the lower left corner of Fig. 6-3.

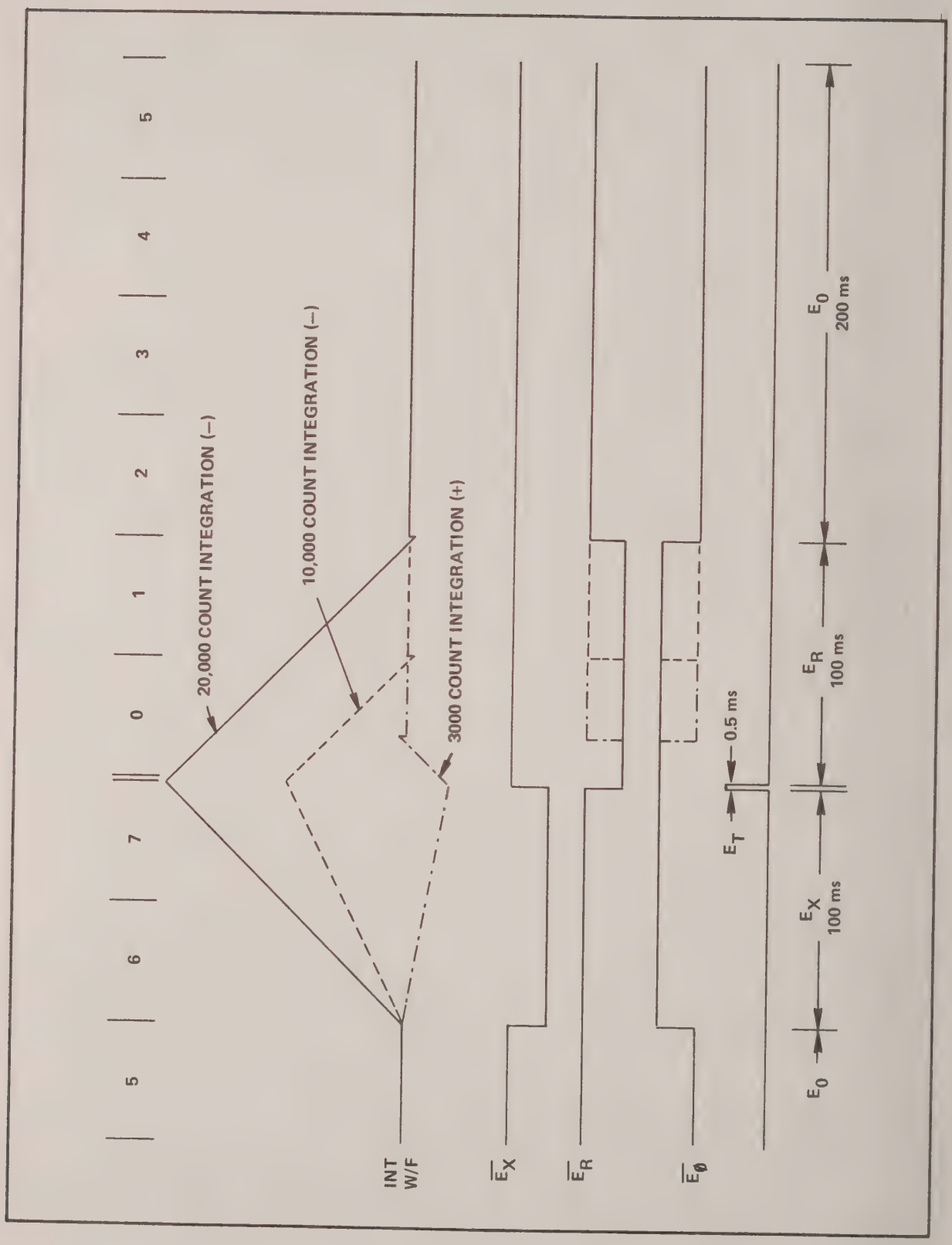


Figure 4-2. Timing Signal Diagram.

4-20 DISPLAY POWER SUPPLY

4-21 A separate winding on transformer A1T1 provides high voltage which is rectified by A1CR2 and filtered by A1C10 to provide 190 volts DC for operation of the seven segment gas discharge displays.

4-22 LOGIC POWER SUPPLY

4-23 A center tapped winding on A1T1 is the source of power for the logic circuits. A full wave rectifier comprised of diodes A1CR3 and A1CR4 followed by filter capacitor A1C11 provide approximately 9 volts DC to the input of the integrated circuit regulator A1IC59. The output of the regulator is positive 5 volts. A1C8 and A1C9 are high frequency by-pass capacitors.

4-24 ANALOG POWER SUPPLY

4-25 The analog power supply obtains its AC power from a separate winding of transformer A1T1. Its output is rectified by diodes A1CR9, A1CR10, A1CR11 and A1CR12 and filtered by capacitors A1C14 and A1C15. The output of this rectifier/filter circuit terminates in Fig. 6-4. There are three regulator circuits at the lower left corner of Fig. 6-4. The circuit of diode A1CR29 and transistor A1Q17 provides positive 5 volts for the integrated TTL logic circuits associated with switching in the analog circuitry. That associated with diode A1CR30 and transistor A1Q18 provides positive 15 volts for the analog circuits and that associated with diode A1CR31 and transistor A1Q19 furnishes negative 15 volts. The common line from the rectifier circuit is connected to the analog secondary shield.

4-26 PRECISION VOLTAGE SOURCES

4-27 The two 10 volt reference sources used as inputs to the integrator during E_R (Reference Timing Diagram, Fig. 4-2) are obtained from the circuits associated with amplifiers A1IC57 and A1IC56 which are found in the lower center of Fig. 6-4. When power is applied to the instrument, the output voltage of A1IC57, at terminal 6, will rise until it reaches the zener voltage of A1CR25 of 6.2 volts. The output of A1IC57 is the source of current for A1CR25. A1CR26 is in series with the output of A1IC57 to prevent it from going in a negative direction. A1R89 and A1CR25 are factory matched sets with A1R89 being selected to provide a precise current through A1CR25. Selecting a value for A1R91 permits a coarse adjustment of the reference voltage and potentiometer A1R93 provides a fine adjustment. The characteristics of this circuit are such that the voltage across A1CR25 will vary less than 500 microvolts over a 25°C change in temperature.

4-28 The inputs to the summing junction of the amplifier circuit of A1IC56 are the +10 volts output of A1IC57 and its own −10 volt output. A1R97 provides a fine adjustment of the −10 volt output.

4-29 INPUT ATTENUATOR

4-30 The HI input terminal, A1J1, is wired to connector A1P8 terminal 3. The connection from terminal 3 to terminal 1 is made with a jumper when the AC converter is not installed and through a pair of normally closed relay contacts when the AC Converter is installed and the instrument is operating in the DC mode. In the 20 mv, 200 mv and 2 volt ranges, relay A1K3 is de-energized and the path to the input of the buffer amplifier is through A1R100 and a pair of normally closed contacts on A1K3. The heavy lines in Fig. 6-3, from the input terminal to A1E3, represent teflon insulated wire as opposed to circuit board traces. This is to insure the lowest possible leakage and maintenance of the high input impedance.

4-31 In the 20 volt and 200 volt ranges, A1K3 is energized and the series resistor string, made up of A1R101 through A1R106 and A1R110, is connected across the input terminals. The path to the input of the buffer amplifier is then from the arm of potentiometer A1R104, through the normally closed contacts of relay A1K4 and one set of normally open contacts of A1K3. In the KV range, A1K3 and A1K4 are energized and the path to the input of the buffer amplifier is from the arm of potentiometer A1R106 and through the normally open contacts of A1K4 and through the normally open contacts, 6 and 7, of A1K3. A1R101, A1R103, A1R105 and A1R110 are furnished in matched sets and should be replaced only with factory supplied sets.

4-32 INPUT CIRCUIT PROTECTION

4-33 FET's A1Q10 and A1Q11 are FET's connected as diodes between the input line and the plus and minus 2.2 volts derived from the reference sources. The FET's connected in this manner, are very low leakage diodes and will conduct whenever the input exceeds 2.2 volts, positive or negative. Since there is always a substantial resistance between the input terminal and A1E3, the current through A1Q10 or A1Q11, in the event of an overvoltage condition, is relatively small and the FET's associated with the input of the buffer amplifier are protected. A1Q10 and A1Q11 are factory selected for

very low leakage. To maintain the instrument's specified performance they should only be replaced with units obtained from the factory.

4-34 BUFFER INPUT SWITCHING

4-35 $\overline{E_X}$, from the logic circuits, enters the diagram of Fig. 6-4 at center left and through A1R29 to photocoupler A1IC44. A1C18 couples the high frequency components of the $\overline{E_X}$ waveform across A1R29 so that the light emitting diode in A1IC44 will turn on and off rapidly. The phototransistor in A1IC44 cannot develop sufficient power to drive the two operational amplifiers A1IC51 and A1IC52 and other gates. Passing the signal through two NAND gates, A1IC47A and A1IC47B, generates the necessary power at the output of A1IC47B to drive those circuits. A1IC51 and A1IC52 are operated open loop and their outputs will switch between plus 15 volts and minus 15 volts in complimentary fashion due to the input connections. Therefore, FET A1Q9 will be turned, on connecting the input voltage to the input of the buffer amplifier, during E_X (reference timing diagram Fig. 4-2). Conversely, FET A1Q12 will be turned on, shorting the input of the buffer amplifier to ground at all times except during E_X.

4-36 It is necessary that the gates of FET's A1Q9 and A1Q12 be operated at the same potential as the drain-source channel. This is accomplished by connecting A1R52 and A1R53 to the output of the buffer amplifier through contacts of relays A1K1 and A1K2 and associated voltage dividers. The relay contacts and voltage divider arrangement will attenuate the buffer amplifier output by the same factor as the amplifier gain. Therefore, the voltage applied to the gates of A1Q9 and A1Q2 will be the same as that applied to the drain-source channel. The relays and voltage dividers are required to change the gain of the buffer amplifier for different input ranges as explained in paragraphs 4-13 and 4-38. The switching of FET's A1Q9 and A1Q12 will generate small transients. These are eliminated by capacitively coupling a small part of the switching voltage to the drain of each FET. Variable capacitor A1C2 provides the means for adjusting the coupled voltage to the level that will just cancel out the transient. A1C23 prevents switching transients from reaching the input terminals.

4-37 BUFFER AMPLIFIER

4-38 The buffer amplifier is shown in Fig. 6-4 and is comprised of dual FET A1Q13 connected as a differential amplifier and in cascade with operational amplifiers A1IC54 and A1IC55. Its input is the gate of the first half of A1Q13 and its output is terminal 6 of A1IC55. The output of the buffer amplifier is also connected to Test Point A1TP1. The feedback to the second gate of A1Q13, and therefore the gain of the total amplifier, is controlled by the contacts of relays A1K1 and A1K2 and the voltage divider to which they are connected. For an input between 0 and 20 millivolts, the voltage at A1TP1 should be between 0 and 2 volts and this requires a gain of 100 in the buffer amplifier. For an input between 0 and 2 volts, the voltage at A1TP1 should be between 0 and 2 volts and this requires a gain of only 1 in the buffer amplifier. The auto-ranging logic circuits control relays A1K1 and A1K2 as well as relays A1K3 and A1K4 in the input attenuator. The order in which these relays are actuated for different input voltage ranges, the input attenuation and the amplifier gain resulting are shown in Tables 4-1 and 4-2.

Table 4-1. Attenuator and Amplifier Gain Switching

RANGE STATE	0	1	2	3	4	5	6	7	8	9
DC MODE RANGE † BUFFER GAIN INPUT ATTENUATOR		10 MV X100 0	100 MV X10 0	1 V X1 0	10 V X10 100:1	100 V X1 100:1	1 KV X1 1000:1			#
AC MODE RANGE† BUFFER GAIN INPUT ATTENUATOR*				1 V X 1 0	10 V X1 10:1	100 V X1 100:1	1 KV X1 1000:1			#
OHMS MODE RANGE† BUFFER GAIN INPUT ATTENUATOR	1 X100 0	10 X10 0	100 X10 0	1 K X10 0	10 K X10 0	100 K X10 0	1 M X1 0	10 M X1 0	100 M X1 0	#

* Input attenuation for AC Converter only. DC attenuation is 0 during AC mode.
\# Any condition that produces a 9 count out of A1IC32 will reset the counter, A1IC6.
† Mid range values shown.

Table 4-2. Relay Operation Matrix

DC VOLTAGE RANGE	A1 (DC) Relays A1K1	A1K2	A1K3	A1K4	A4 (OHMS Relays) A4K2	A4K3	A4K4	A4K5	A4K6	A4K7	A3 (AC) Relays A3K2	A3K3	A3K4	RANGE STATE
20 mv	X													1
200 mv		X												2
2 Volt														3
20 Volt		X	X											4
200 Volt			X											5
1200 Volt			X	X										6
RESISTANCE RANGE														
2 Ohm	X				X									0
20 Ohm		X			X									1
200 Ohm		X				X								2
2 K Ohm		X					X							3
20 K Ohm		X						X						4
200K Ohm		X							X					5
2M Ohm									X					6
20M Ohm														7
200M Ohm										X				8
AC VOLTAGE RANGE														
2 Volt														3
20 Volt											X			4
200 Volt												X		5
1100 Volt													X	6

4-39 To achieve the specified accuracy on all ranges, the feedback from the output of the buffer amplifier to the second gate of the differential amplifier, A1Q13, must be precisely adjusted so that the closed loop gain of the buffer amplifier is reduced (or increased) by exactly ten between each step. Potentiometers A1R73 and A1R75 provide that adjustment capability. The manner in which these adjustments are made is covered in Section V, Maintenance. As stated, A1Q13 is operated as a differential amplifier. This requires a constant current source which is provided by the current regulator circuit of transistor A1Q14.

4-40 INTEGRATOR AND COMPARATOR

4-41 The input to integrator A1IC53 is the summing junction of A1R78, A1R79 and A1C30. Because of the large feedback provided by A1C30, the output of A1IC53 will tend to change very slowly to a step change in voltage at A1TP1 and its output waveform during E_X time will be as shown in Fig. 4-2. The comparator, amplifier A1IC58, is operating open loop and its principal function is to provide a steep transition between one output condition (+) and the other (–) at zero crossover.

4-42 During the E_0 period, the input to the buffer amplifier is shorted to ground as explained in paragraph 4-35. Therefore, the potential at test point A1TP1 will be offset from zero only by the small amount due to drift or initial offset in the buffer amplifier. FET A1Q16 is also turned on during the E_0 period and closes the loop around A1IC53 and A1IC54 through the voltage divider A1R86 and A1R88, source follower A1Q15 and A1R79. The signal from this feedback loop applied to

the summing junction at the input to A1IC53 will cancel out any offsets in the buffer amplifier or in the integrating amplifier and comparator. The output of the comparator will be driven to zero.

4-43 If one connected an oscilloscope to the source of A1Q15, a lot of hash would be observed during the E_0 period which is the result of the loop trying to correct itself to zero. The comparator is operating open loop and has considerable gain which accounts for this effect. A1R82 and A1C31 filter out this hash and A1C31 is charged to the average value. At the end of E_0, A1Q16 is turned off and the charge on A1C31 holds the voltage applied to the source of A1Q15 at the value that achieved the zero condition at the output of the comparator. Thus all offsets in the buffer amplifier, integrator and comparator have been cancelled out.

4-44 At the transition from the E_0 period to the E_X period, FET A1Q12 is turned off, removing the short circuit to ground from the input of the buffer amplifier. Simultaneously, FET A1Q9 is turned on connecting the input of the buffer amplifier to the output of the attenuator. The voltage at A1TP1 will immediately rise to a value between 0 and 2 volts represented by the level of the voltage applied to the input and the amount of attenuation. The output of the integrator will begin to fall (or rise in the case of a negative voltage applied to the instrument input). The level to which it will fall or rise in the time represented by E_X will be a direct function of the applied voltage as shown in Fig. 4-2.

4-45 At the end of the E_X period, FET A1Q12 is again turned on shorting the input of the buffer amplifier to ground and the voltage at A1TP1 returns to near zero. At the same instant, a precision 10 volt reference is connected to the summing junction of the integrator through a 250K ohm resistor. The polarity of the reference will have been determined by logic circuits that sample the polarity of the output of the comparator at the end of E_X as explained in paragraph 4-64. The polarity of the reference voltage is opposite to that which was applied to the input of the integrator during the E_X period and tends to discharge A1C30 toward zero. The discharge slope is always the same during the E_R period, therefore, the time to reach zero will be a function of the charge on the capacitor A1C30 at the end of E_X which was a function of the voltage applied to the instrument input terminals.

4-46 At the time of transition between the E_X and E_R states, any noise at the output of the comparator caused by switching transients, or from any other source, could trigger a false zero and give an erroneous reading. This is prevented by E_T (reference timing diagram Fig. 4-2), which disables the logic circuits for 0.5 milliseconds following the end of E_X. However, the integration of the reference voltage was started at the transition from E_X to E_R and, unless compensated for, the logic circuits would measure the integration of the reference from the end of E_T until the output of the comparator crossed zero. The time for the integration of the reference would then be measured as being 0.5 milliseconds shorter than actually required. As compensation, the output of the comparator is offset by applying a small voltage of the proper polarity to its inverting input during the E_R period. (This is covered in the paragraph on Reference and Offset Switching, 4-50.) The net effect is that the output of the comparator crosses zero 0.5 milliseconds later than it would without this compensation. Since the 0.5 millisecond period of E_T is generated in the logic circuits and measured by the crystal controlled clock oscillator, the compensation is very precise.

4-47 The integrated waveform shown in timing diagram, Fig. 4-2, is the waveform at the output of the integrator and shows the integration of the reference proceeding beyond zero then returning to zero. This is necessary because of the aforementioned offset of the comparator which will cause its output to pass through zero 0.5 milliseconds after its input passes through the zero reference. Integration of the reference to produce a zero crossover at the comparator output with a two volt input having been applied to the buffer amplifier, would require 100 milliseconds. This is the total time for E_R and zero detect would not occur in the E_R period. The clock count would be 20,000 and the instrument would indicate an overrange condition in the manual range mode or step into the next higher range in the autorange mode.

4-48 ANALOG SWITCHING

4-49 Analog switching circuits not covered in previous paragraphs are those associated with the integrator and comparator. These will be found in the upper portion of Fig. 6-4. A description of these circuits is contained in paragraphs which follow.

4-50 REFERENCE AND OFFSET SWITCHING

4-51 The positive reference voltage switch is A1Q2 and the negative switch is A1Q3. These are both FET's and the channel resistance, when turned on, is approximately 50 ohms which is a negligible fraction of the series resistors A1R39 and A1R40. When A1Q2 is conducting, its source will be at ground potential. Diode A1CR15

will be zero biased and will have no effect on operation of the circuit. When A1Q2 is turned off, the voltage at its source will not rise above 0.65 volts due to the forward bias on A1CR15. This prevents any leakage through A1Q2, during the time it is not conducting, that could have an adverse effect on the accuracy of the instrument. Diode A1CR16 serves a similar purpose for A1Q3.

4-52 FET's A1Q4 and A1Q5 are the comparator offset switches, their sources of current are the two reference sources but taken from voltage dividers because the offset voltage requirement is only a small fraction of the reference 10 volts. Potentiometers A1R45 and A1R48 provide adjustments for the offset levels.

4-53 A reference and an offset voltage must be turned on at the end of E_X. Which is turned on, and which remains off, is determined by the polarity of the comparator output at the end of E_X. When the comparator output is positive, transistor A1Q6 will be turned on and its collector voltage will be at near-ground potential. NOR gate A1IC45D will invert the low potential to a high at its output. This is then fed back to the base of A1Q6 to insure a positive turn on of the transistor. If the comparator output is negative, A1Q6 will not be turned on and its collector, and the input to NOR gate A1IC45 will be high producing a low at the output of the gate. At the end of E_X, the output state of A1IC45D, which appears at the D input to flip-flop A1IC46B, will be clocked through A1IC46B. In the case where the D input is high, the Q output will be high and the $\overline{Q}$ output will be low. Flip-flop A1IC46A is also clocked at the end of E_X by the rising edge of the $\overline{E_X}$ pulse. Its D input is tied to ground and this low state, when clocked through, will force its $\overline{Q}$ output to a high state. $\overline{E_X}$ is high after the end of the E_X period and the $\overline{Q}$ output of A1IC46A is high. The truth table for the SN7400N NAND gate shows that with these inputs the output of NAND gate A1IC47D will be in a low state. This presents a low at one input of NAND gate A1IC45C. The low state of the $\overline{Q}$ output of A1IC46B is at the other input and the output A1IC45C goes to a high state. This drives the output of operational amplifier A1IC50 positive turning on positive reference switch A1Q2 and negative offset switch A1Q5.

4-54 In the other case, where the D input to A1IC46B is low (comparator output negative), both inputs to NOR gate A1C45B will be low and its output high forcing the output of operational amplifier A1IC49 positive and turning on the negative reference switch A1Q3 and positive offset switch A1Q4. At the moment of zero transition, the output of NOR gate A1IC45D will change state and NOR gate A1IC45A output will change state. This change of state will be relayed to the logic circuits through photocoupler A1IC42 and will be detected as the zero transition. STOP is instantly generated by the logic circuits and through photocoupler A1IC43 sets flip-flop A1IC46A. Its $\overline{Q}$ output then goes low. Through A1IC47, the active gate, NOR gate A1IC45B or A1IC45C, will change output state shutting off the reference and offset switches.

4-55 The state of the Q output of A1IC46A will determine the on or off condition of FET A1Q16, which completes the autozero feedback loop, through its control of operational amplifier A1IC48. The Q output of A1IC46A will be low from STOP until the start of E_X. This forces the output of operational amplifier A1IC48 high turning on A1Q16.

4-56 TIMING SIGNAL GENERATION

4-57 The timing signals of the DMM-42 are generated in the logic circuits of Fig. 6-3. Quartz crystal Y1 and the associated inverters of A1IC49 comprise a 1 MHz oscillator which drives a string of decade counters. Counter A1IC13 is connected to divide the crystal oscillator frequency by 5. The decade counters are clocked by the falling edge of the clock signal at terminal 14. Each time the counter has counted through 10 (five in the case of A1IC13), the output on terminal 11 will be going in a negative direction and will clock the following counter if it is not inhibited. Decade counter A1IC15 may be referred to as the state counter and the reason will be clear at the end of this discussion. There are eight states in the measurement cycle as shown on the timing diagram, Fig. 4-2. They are 0 through 7 with autozero occuring during states 2 through 5, E_X occuring during states 6 and 7 and E_R occuring during states 0 and 1. It should be noted here that the E_R condition may not last as long as the duration of states 0 and 1 but will be terminated at the zero transition of the comparator. The system will return to the auto zero condition, however the remaining time for states 0 and/or 1 will merely be added to the four auto zero states.

4-58 The timing signal $\overline{7}$, which is used only in external equipment, is generated at the output of NAND gate A1IC36C. Counter A1IC15 is connected at terminals 2, 3 and 11 so that it clears after the count of 7. At the count of 7, all its outputs are in a high state and applied to inputs of A1IC36. The output of A1IC36 goes to a low state until A1IC15 clears then returns high completing the $\overline{7}$ pulse.

4-59 Timing signal $\overline{E_X}$ is created in both NAND gates A1IC23B and A1IC23C. The output of A1IC23B is connected only to the input of photocoupler A1IC44, Fig. 6-4. The output of A1IC23C is used to generate other signals in the system. During the count of 6 and 7 in counter A1IC15, terminals 8 and 9 are both high. These outputs are connected to the two inputs of NAND gates A1IC23B and A1IC23C and their respective outputs go low satisfying the condition for $\overline{E_X}$ as shown in the timing diagram, Fig. 4-2. When the counter, A1IC15, clears at the end of the count of 7, the high inputs to the two NAND gates are removed and the outputs return to a high state.

4-60 $\overline{E_R}$ is generated at the output of NAND gate A1IC23A. As the counter A1IC15 clears at the end of state 7, the Q output of flip-flop A1IC18A is set high by the $\overline{E_X}$ pulse at the output of A1IC23C. Both inputs to NAND gate A1IC23A are now high and its output goes to a low state as shown in the timing diagram, Fig. 4-2, as the starting condition for $\overline{E_R}$. At the count of 2, which occurs two states later, flip-flop A1IC18A is clocked by the output of A1IC15, terminal 9. This transfers the low at the D input of A1IC18A to its Q output and to one input of A1IC23A ending $\overline{E_R}$. This is correct only if $\emptyset$ DET did not transition through zero prior to the start of State 2 (count of 2 in A1IC15). The output of NAND gate A1IC25A and A1IC25B is a very short pulse when the $\emptyset$ DET line transitions through zero. This resets flip-flop A1IC18A which will set the Q output low. This is the same output condition that would have occured if A1IC1 had reached the count of 2 and will terminate $\overline{E_R}$ by making the input terminal 1 of A1IC23C low.

4-61 Timing signal $\overline{E_T}$, which is not shown on the schematic diagram, is generated concurrently with the leading edge of $\overline{E_R}$. The output of A1IC23C goes low at the beginning of $\overline{E_R}$. This transition is conveyed to the inputs of A1IC24C through two separate paths, One, through A1R10, will introduce a delay due to the time required to charge A1C2. The other, through the inverter, A1IC26-8, will introduce no delay. The two inputs to A1IC24C, therefore, will be high and its output low until A1C2 is charged. This period is approximately 0.2 μsec. Thus, a 0.2 μsec negative going pulse will appear at the output of A1IC24C. This pulse sets flip-flop A1IC18B. At this moment, all outputs of the counters are low. The high at the Q output of A1IC18B will inhibit decade counter A1IC17. After decade counter A1IC11 has counted through ten, the potential at its terminal 11 will fall. Normally, this would clock counter A1IC17 but it is inhibited as stated. The falling edge, inverted through A1IC19, will clock flip-flop A1IC18B transferring the low at the D input to the Q output. This will clear A1IC17 to begin counting at the next falling output from terminal 11 of A1IC11. The counting delay is equal to one cycle of the 2 KHz pulse rate at the output of A1IC11 or 0.5 milliseconds shown for E_T in the timing diagram Fig. 4-2.

4-62 STOP is generated at the output of inverter A1IC26 terminal 2 and is the complement of the Q output of flip-flop A1IC18A. It has a variable length starting at zero transition or the end of state 1, whichever first occurs, and terminating at the end of E_X. It is started by $\emptyset$ DET transitioning through zero. During the E_X period, the state of the $\emptyset$ DET line will be high for a positive input and low for a negative input. In the case where $\emptyset$ DET is high, it will be inverted to a low at terminal 4 of inverter A1IC39 and back to a high at terminal 2 of A1IC39. Thus the level at terminal 2 of quad latch A1IC1 is high and will be clocked to the output terminal, 16, by a pulse at terminal 13 originating at the output of NAND gate A1IC24C at the end of E_X. Thus the polarity of the input is stored at terminal 16 of A1IC1 with the complement stored at terminal 1. This produces a low on terminal 1 of A1IC25A and a high on terminal 12 of A1IC25B. $\overline{E_R}$ is inverted at terminal 8 of A1IC26 and places a high at terminal 4 of A1IC25A and terminal 10 of A1IC25B. Both NAND gates, A1IC25A and A1IC25B have two inputs in a high state and two in a low. At the time of zero transition, $\emptyset$ DET goes low and, because it is inverted, places a high on terminal 13 of A1IC25B. The Q output of flip-flop A1IC18B was clocked to a low at the end of E_T placing one input of NOR gate A1IC35B in a low state. At the next falling output from counter A1IC13, the other output will go low and its output will go high as will the terminal 9 input to NAND gate A1IC25B. With all inputs high, the output of A1IC25B will go low resetting flip-flop A1IC18A. This is a very short pulse as the resetting of the flip-flop stops $\overline{E_R}$ and removes one of the high inputs from A1IC25B causing the latter's output to return to a high state. The reset of the flip-flop set the $\overline{Q}$ output high and the Q output low. The $\overline{Q}$ output is connected to one input of NAND gate A1IC24B and the Q output to the other but through a resistor capacitor network, A1R12 and A1C3. The R/C network will delay the arrival of the low at the input to the NAND gate. The result is a very short (0.2 μsec) negative pulse at the output of A1IC24B labeled $\overline{\text{STROBE}}$. When the $\emptyset$ DET line is negative during E_X, the same sequence of events takes place except that the polarities at the outputs of A1IC1 are reversed and A1IC25A provides the reset pulse for A1IC18A.

4-63 DATA READY is another timing signal used to signal a computer, or other peripheral device, connected to the unit that data is ready to be recorded. It is generated at the output of NAND gate A1IC24A. The NAND gate flip-flop comprised of A1IC24D and A1IC27D is set by $\overline{E_X}$, placing a high on the one input of A1IC24A. When flip-flop A1IC18A is triggered by A1IC25 at zero detection, or by a clock pulse from A1IC15 at the count of 20,000, a high is placed on the other input of A1IC24A forcing its output to a low state. This will be delayed arriving at the input to inverter A1IC26 terminal 3 by the R/C network of A1R13 and A1C4. If the input voltage to the unit is out of range and the unit is in the autorange mode, an up range or down range pulse at the input of A1IC27C will reset the latch. This will cause the output of A1IC24A to return to a low state. This sequence will occur with sufficient speed to prevent a pulse being generated at the output of A1IC26 terminal 4.

4-64 POLARITY SENSE

4-65 Ø DET will be high during E_X for a positive input and low for a negative input. This must be sensed at the end of E_X and stored until zero transition. Refer to Fig. 4-3 which is a simplified diagram of the circuits involved. If Ø DET is high at the end of E_X, a high will appear at input terminal 2 of quad latch A1IC1. This will be clocked through to terminal 16 by a short pulse at the output of NAND gate A1IC24C at the time of transition from E_X to E_R. With terminal 16 of A1IC1 high, transistor A2Q1 will turn on illuminating the (+) sign in the display. If Ø DET were negative at the end of E_X, the input to A1IC1 terminal 2 would be low and when clocked, terminal 16 would be low and terminal 1 high which would illuminate the (–) sign in the display. The display of a plus or minus sign will not occur if the instrument is in the AC or OHMS mode of operation. The two

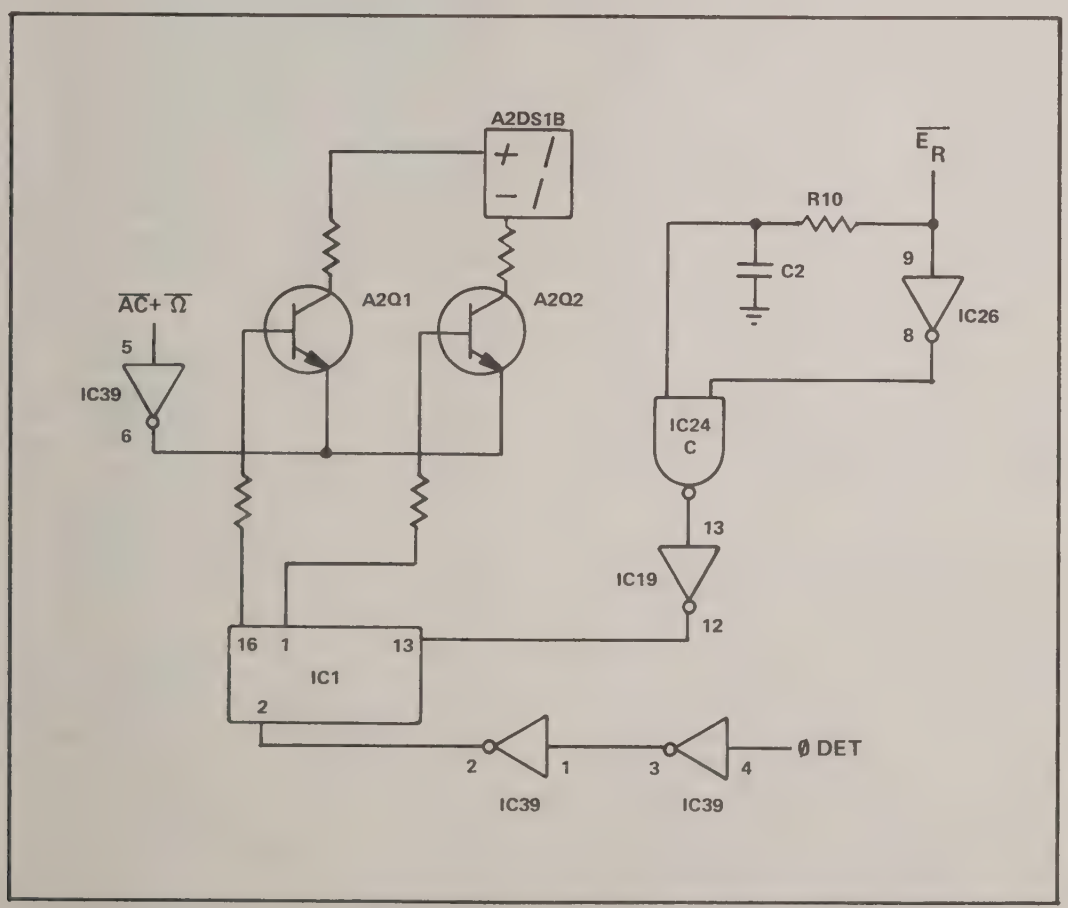


Figure 4-3. Polarity Sense Logic Circuit

during transitions A2Q1 and A1Q2 will be maintained at the output terminal 3 of A1IC14 going high during these two modes as explained in the paragraph on annunciator logic 4-91.

4-88 DISPLAY CONTROL LOGIC

4-87 From the end of the E_X period until zero detection occurs through operation of the counters A1IC11, A1IC10, A1IC9, A1IC7, A1IC6 and A1IC5 are counting the crystal oscillator, or more properly, the 2M Hz output of A1IC15 is being counted. When zero crossover occurs at the output of the comparator, the logic circuits generate the STROBE pulse which is inverted and then applied to the clock inputs of quad latches A1IC1, A1IC2, A1IC3, A1IC4, and A1IC5. The outputs of the counters appear at the input to the quad latches and the count will be stored through to their outputs where they will be held until the next STROBE pulse clocks through a new count. The output of the quad latches are connected to BCD-to-seven-segment decoder drivers which, due to their negative-go strobing input, cause the display to blank during input to the decoder drivers, terminal number 4 is normally high when the count is $19,000$ or lower. If the count exceeds that number, the binary 2 output of A1IC15 terminal 5 will be high and this will be stored through A1IC1 at its terminal 14 by STROBE setting the input to NAND gate A1IC16D high. The counters continue to count the clock, however, and the binary 4 output of A1IC15 terminal 1 will change from high and low at a 2.5 times per second rate. This, applied to the other input of NAND gate A1IC16D will cause its output to shift from high to low in the same manner. A1IC16D is connected to the blanking input of the decoder drivers and they will be alternately enabled and disabled causing the entire display to blink on and off at a 2.5 times per second rate indicating an over range condition.

4-86 The decimal indicators in the display elements are controlled by the ranging system as explained in paragraph 4-84.

4-89 UP/DOWN RANGING

4-71 The Up/Down ranging system of the DMM-4 has two modes of ranging operation, however, the same basic system operates in both modes. Range control is accomplished with digital logic circuits and with a number of interlocks so that improper ranges are not selected when the instrument is in an operational mode for which a range is not available. The logic which controls the ranging system is quite complex of necessity. An examination of Figure 4-1 shows that the ranges differ for each operational mode, that the attenuation in the main frame input section may or may not be inserted depending on operational mode and that the buffer amplifier gain for a given range state changes from one operational mode to another. The reason is that the AC Converter and the OHMS Converter vary considerably from range to range in the voltage that they apply to the input attenuator section of the main frame. The main frame must then adjust itself to this input voltage to provide the correct reading in the display.

4-72 Autorange control is selected by depressing the AUTO button on the front panel. In the Autorange mode, the instrument samples the input voltage and if the output of the integrator at the end of E_X is at high that integration of the reference produces a count in excess of $19,000$, the instrument will not display that number but will uprange the system one step and then again sample the input voltage. This process is repeated until the count at the end of the E_X period is $19,000$, or less, at which time it will display the reading. If the count is not $19,000$, or less, on reaching the highest range, the display will begin to blink indicating an over range condition. If the integration of the reference produces a count of less than 1000, the unit will display that number but will immediately down range one step, sample the input voltage again and begin the reading. This process will be repeated until a count of 1000 or more is obtained or until the lowest range for the mode of operation is obtained. For manual operation of a reading less than 1000 the operator can manually down range the unit.

4-73 The range can be moved up or down manually with the AUTO button depressed only over the limited range that does not produce a display of less than 1000 or more than $19,000$. Manual control of the range is accomplished by releasing the AUTO button and pressing the UP or DOWN button as desired. The range will change at the rate of two and one-half times per second.

4-74 The heart of the ranging system is the combination of A1IC11, an up-down BCD counter, and A1IC12, a BCD to decimal decoder. The ranging logic drives the counter up or down one step at a time and the decoder converts the BCD code on the A1IC11 output terminals 1, 2, 6 and 7 to a low on its appropriate output terminal.

4-75 DOWN RANGE LOGIC

4-75 Refer now to Fig. 4-2 which is a simplified diagram of the down range logic. The basic concept of

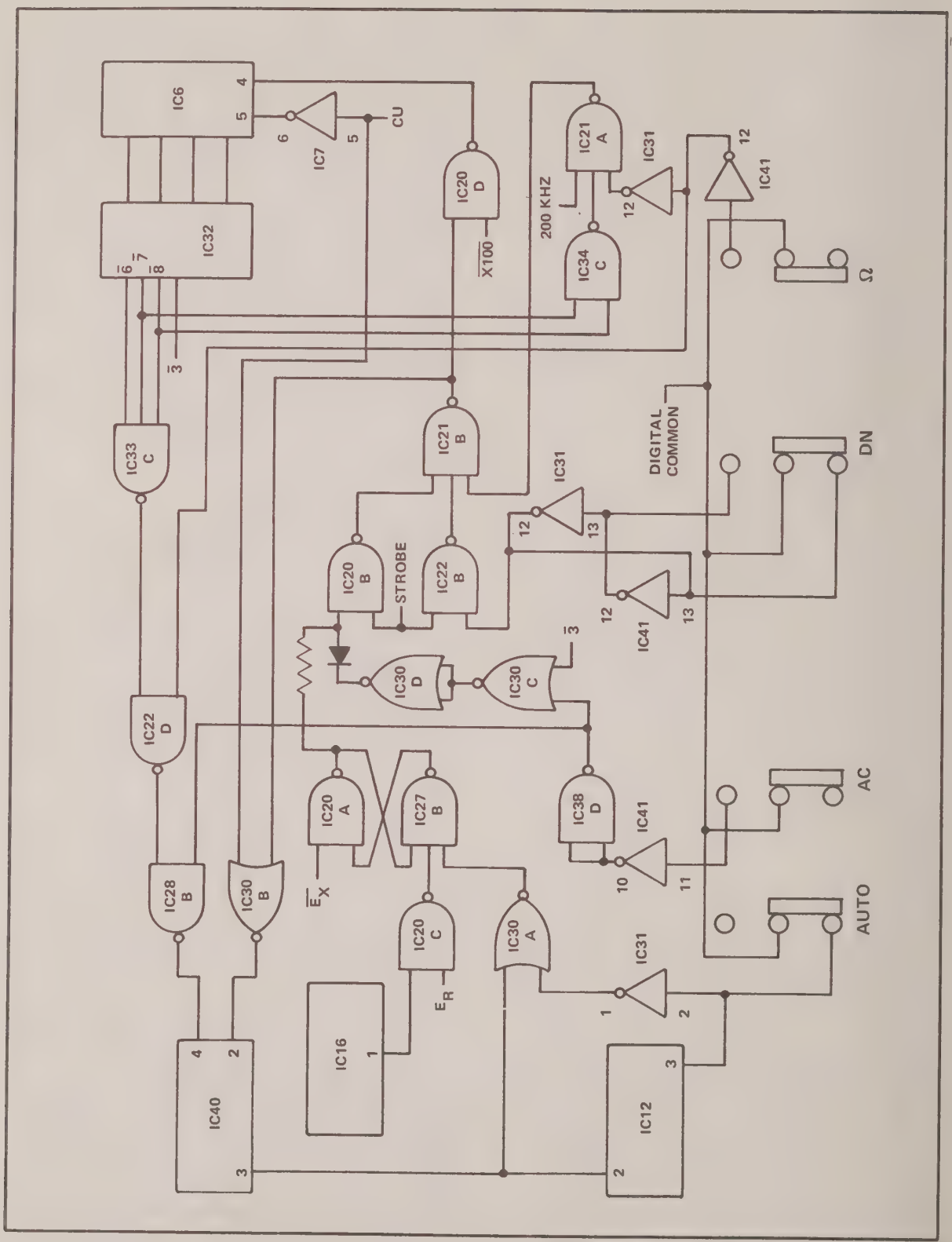


Figure 4-4. Down Range Command Logic Circuit.

states 6, 7 and 8 due to the action of NAND gate A1IC33C. One input of A1IC28B is maintained in a high state by the open AC switch and its connection to A1IC28B through A1IC41 and A1IC38D. With these two gate inputs high, the triggering of A1IC40 will be controlled by the path from A1IC32 through A1IC33C, A1IC22D and A1IC38B. The only controls here are the inputs to A1IC33. One of these will be low during range states 6, 7 and 8 and the chain of events to the input of A1IC40 will enable it during these three states which are the three highest resistance ranges. When the output of A1IC40 is high, it also inhibits counter A1IC12, which is the least significant bit counter, and counting will not occur until A1IC40 times out.

4-80 UP RANGE LOGIC

4-81 Refer now to Fig. 4-5 which is a simplified diagram of the up range logic. In the auto range mode, the AUTO switch is depressed and the input to A1IC31-1 is high and its output will be low. As stated in the paragraph on down range logic, the output of A1IC40 terminal 3 is low except for short periods when the unit is in the OHMS mode of operation and in the megohms ranges and on all ranges in the AC mode of operation. The output of NOR gate A1IC30A is, therefore, high. If the count is 20,000 or more before the end of E_R, the binary count 2 output of counter A1IC15 (terminal 9) will go to a high state momentarily making all inputs to NAND gate A1IC27A high. Prior to this event, both inputs to NAND gate A1IC28A were high and its output low. The occurance of the 2 output of A1IC15 going to a high state results, therefore, in the output of A1IC28A going to a high state. At the end of E_R, the situation will reverse and the output of A1IC28A will return to its low state. The output of A1IC28A is then a positive going pulse. Its length will depend on the time between the point where the count reaches 20,000 and the end of E_R. This pulse will clock the up-down counter, IC6, up one step if allowed to pass through the gates between the output of A1IC28A and the input to the counter. In either the DC or AC mode, the output of NOR gate A1IC35D will be low except in range state 6. Because of the inversion through A1IC31 terminal 8, one input of NAND gate A1IC29C will be held low during range state 6 and the up count pulse cannot pass through to the counter input. In the OHMS mode, the switch closure creates a high at one input of NOR gate A1IC35D and the low state of $\overline{6}$ will have no effect on the output of A1IC35D which will remain low at all times allowing the up-range pulse to pass through NAND gate A1IC29. A1IC29C will be inhibited from passing up range pulses beyond range state 8 by the low on its one input connected to the $\overline{8}$ output of decoder A1IC32. If the system has been operating in the OHMS mode and in one of the lower three ranges and is then switched to AC, it will immediately up range to range state 3. Closing the AC switch places a high on the input of A1IC29A that is connected to A1IC41. If the system is in the 0, 1 or 2 state, one input to NAND gate A1IC33A will be low forcing its output high and making another input to A1IC29A high. The first positive going edge of a 200 KHz clock pulse will force the output of A1IC29A low creating an up range pulse. As long as the system is in one of the three lower range states, the 200 KHz pulses will continue the up range process until range state 3 is reached.

4-82 Refer to the diagram of the down ranging logic, Fig. 4-4, and note that the input to counter A1IC7 terminal 5 is also connected to one input of A1IC30B. A1IC30 will trigger A1IC40 whenever an up or down pulse occurs when the unit is in the AC mode of operation or when it is in the OHMS mode of operation and in one of the megohm ranges.

4-83 GAIN AND ATTENUATION CONTROL LOGIC

4-84 The ranging system provides automatic control of the mainframe front end attenuation and of the gain in the buffer amplifier as required for the range selected in either the automatic or manual range selection mode. Fig. 4-6 is a simplified diagram of the logic circuits employed to effect this control. The following discussion will cover the DC, AC and OHMS modes of operation in that order.

4-85 In the DC mode, the output of NOR gate A1IC35C and NAND gate A1IC38D are always high because of the inputs from the AC and OHMS switches. The high output of A1IC35C will make one input to NAND gate A1IC37C high. The other will be high in range states 4, 5 and 6 as the C output of counter A1IC6 is binary digit 4 which is always high in those three states. $\overline{\text{HI DC}}$ will be low, closing relay A1K3 in the attenuator, only during these states.

4-86 The inputs to NAND gate A1IC36A will be high except during states 2 and 4 at which time its output will go high. The input to NAND gate A1IC36B from NAND gate A1IC22D will be high except during states 6, 7 and 8. The input from A1IC38D to NAND gate A1IC36B will always be high in the DC mode. With this information we can construct a truth table for A1IC36B.

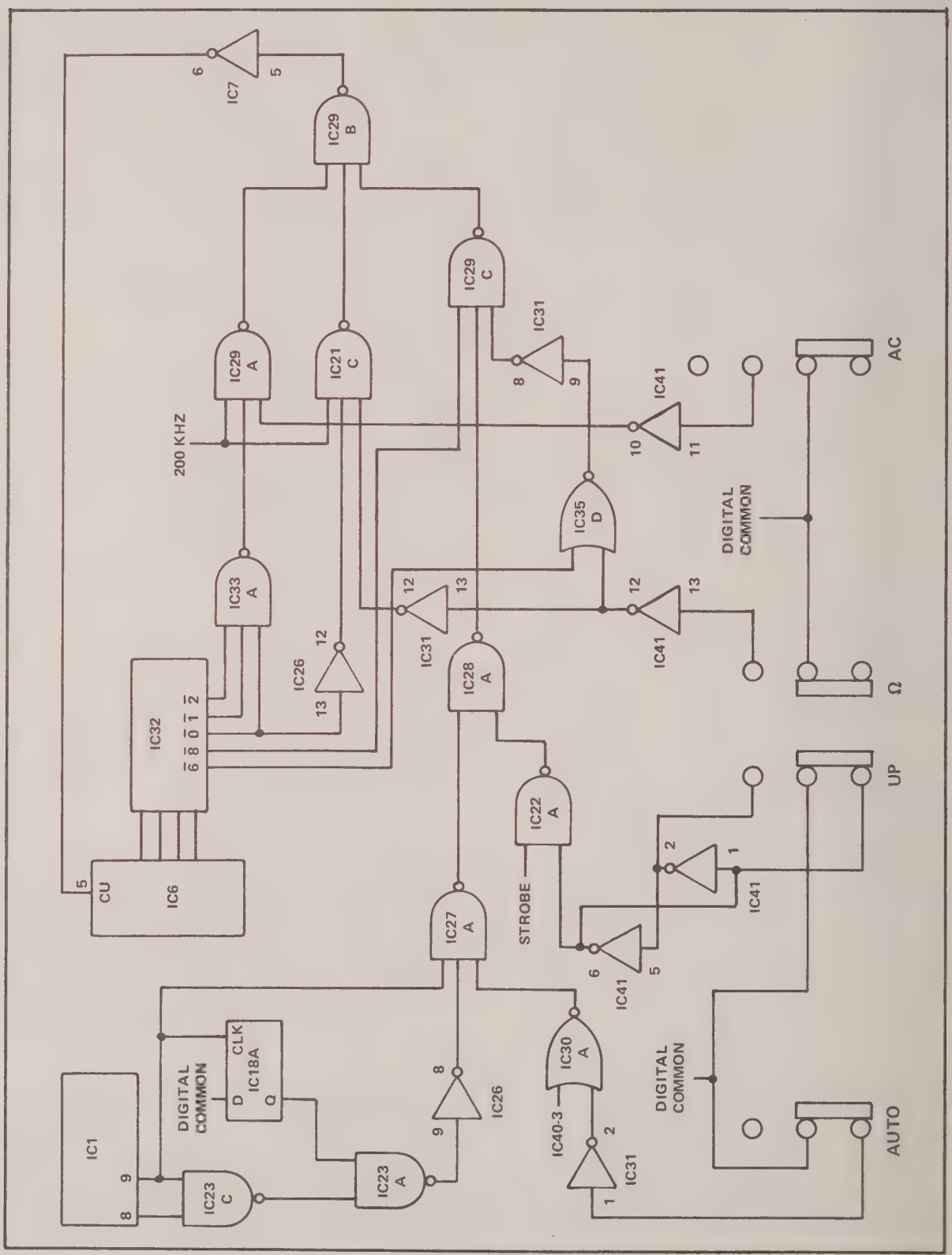


Figure 4-5. Up Range Command Logic Circuit.

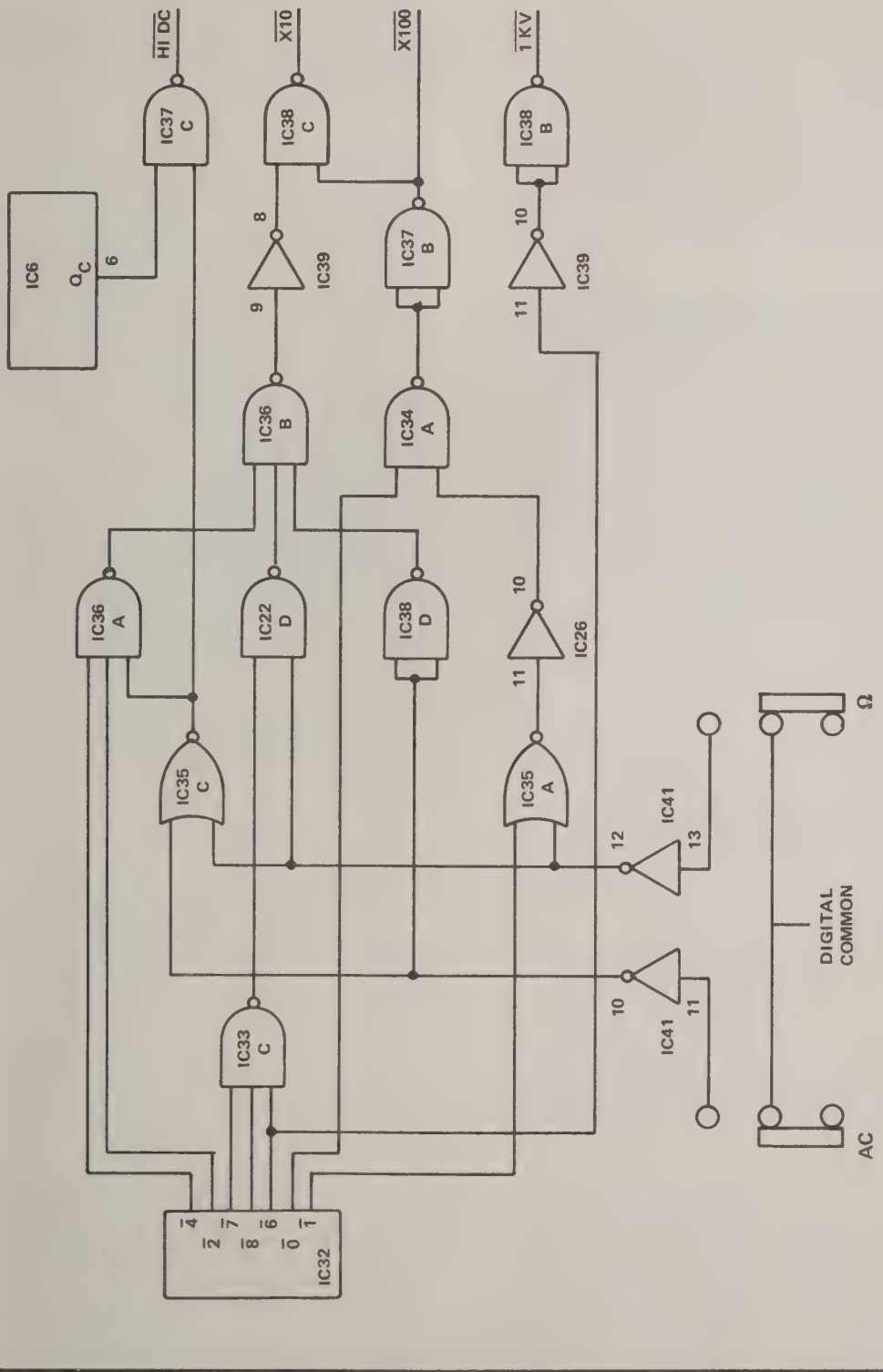


Figure 4-6. Attenuation and Gain Control Logic Circuits.

Range State	0	1	2	3	4	5	6	7	8
A1IC36A Output	L	L	H	L	H	L	L	L	L
A1IC22D Output	H	H	H	H	H	H	L	L	L
A1IC38D Output	H	H	H	H	H	H	H	H	H
A1IC36B Output	H	H	L	H	L	H	H	H	H

Table 4-3. Truth Table for A1IC36B in DC Mode

4-87 The inputs to A1IC35A will both be low only during range state 1. Its output will go high and the input to NAND gate A1IC34A will go low because of the inverter, A1IC26. The other input to A1IC34A will be low only during the 0 range state. Therefore, the output of A1IC34A will be high only during the 0 and 1 range state. In the DC mode, range state 0 is not valid. It is then proper to say that it goes low only in the 1 state. This output is inverted in NAND gate A1IC37B to a low creating $\overline{X100}$. $\overline{X100}$ is an input to NAND gate A1IC38C as is the output of A1IC38B after inversion by A1IC39-8. We can combine the output of A1IC39-8 (the inverted output of A1IC38B shown in the truth table of the preceding paragraph) with the condition for $\overline{X100}$ and create a truth table for A1IC37C.

Range State	0	1	2	3	4	5	6	7	8
A1IC39-8 Output	L	L	H	L	H	L	L	L	L
A1IC37B Output	L	H	H	H	H	H	H	H	H
A1IC38C Output	H	H	L	H	L	H	H	H	H

Table 4-4. Truth Table for A1IC38C in DC Mode.

Thus we see that the $\overline{X10}$ line goes low at range states 2 and 4 in the DC mode. The $\overline{1\ KV}$ line will go low only at range state 6. Compare the above with Table 4-1 and note that it satisfies the requirements for DC operation.

4-88 In the AC mode of operation, the AC switch is closed placing a high on the input of A1IC35C forcing its output low and inhibiting A1IC37C so that the $\overline{HI\ DC}$ line never goes to a low state. The AC switch closure also inhibits A1IC36B, through A1IC38D, preventing the $\overline{X10}$ line from ever going to a low state. The inputs to A1IC34A never go low in AC operation because range states 0 and 1 are never reached. Therefore, the output of A1IC37B ($\overline{X100}$) remains high. The $\overline{1\ KV}$ line will go low in range state 6 because of its direct tie in with the $\overline{6}$ output of A1IC32. These are the proper conditions for operation in the AC mode as shown in Table 4-1.

4-89 In the OHMS mode, A1IC35C will have a low output at all times due to the closed OHMS switch. This will disable A1IC37C and the $\overline{HI\ DC}$ line will remain high during the OHMS mode. A1IC35A will have a high at one input at all times, also, its output will remain low during the OHMS mode presenting a high to one input of A1IC34A after the inversion of A1IC26. The other input to A1IC34A will be low only during range state 0. The output of A1IC34A will then be high only during range state 0 and, because of the inversion of A1IC37B, the $\overline{X100}$ line will go low only during range state 0. Because of the low input from A1IC35C, A1IC36A will be disabled during the OHMS mode and its output will present a high to the input of A1IC36B. A1IC38D will have a high output during the OHMS mode and this will exist at one input to A1IC36B. The input to A1IC36B from NAND gate A1IC22D will be high at all times except during range states 6, 7 and 8. A1IC36B output then, will be low except during range states 6, 7 and 8 and the input to NAND gate A1IC38C will be high except during states 6, 7 and 8. The inputs to A1IC38C for each range state are shown in Table 4-5 below.

Range State	0	1	2	3	4	5	6	7	8
A1IC39 Output	H	H	H	H	H	H	L	L	L
A1IC37B Output	L	H	H	H	H	H	H	H	H
A1IC38C Output	H	L	L	L	L	L	H	H	H ($\overline{X10}$)

Table 4-5. Truth Table for A1IC38C in OHMS Mode

Comparison of this table with Table 4-1 demonstrates that all the requirements for buffer amplifier gain control in the OHMS mode have been satisfied. The $\overline{1\ KV}$ line will always go low at range state 6. However, this will have no effect in the AC or OHMS mode as the $\overline{HI\ DC}$ line must also be low for the relay in the input attenuator connected to the $\overline{1\ KV}$ line to have any effect.

4-90 ANNUNCIATOR CONTROL LOGIC

4-91 The annunciator control logic is also a part of the ranging system and a simplified logic diagram is shown in Fig. 4-7. In the DC mode, Annunciators A2DS5, A2DS6 and A2DS7 are inhibited by the low state at the output of inverter A1IC41 terminal 12 and will not light. Annunciator A1DS3 is also inhibited by the low state at terminal 10 of A1IC41. Annunciator A2DS4 is turned on by both inputs of NOR gate A1IC35C being low and the output being high and then inverted by inverter A1IC39. The voltage range annunciators will be turned on by the state of the outputs of A1IC32. In the DC mode, only range states 1 through 6 are valid. In state 1, the output of NAND gate A1IC33A will be high as is the output of inverter A1IC31 terminal 12. This puts two high inputs on NAND gate A1IC14B and its output will go to a low state lighting the MV annunciator, A2DS8. It will remain on during state 2 as well since the output of A1IC33 remains high. As the range state progresses to 3, 4 and 5, the V annunciator, A2DS9 will be illuminated as NAND gate A1IC33B output is high. The logic for the LED annunciators for the OHMS and AC ranges operate in a similar manner and it is relatively easy to check the logic from the diagram of Fig. 4-7.

4-92 DISPLAY DECIMAL LOGIC

4-93 The display decimal control logic is shown in Fig. 4-7 in simplified form. A1IC6 is the ranging system up-down counter and A2IC5 is a BCD to Decimal decoder-driver. The decimal point of display A2DS2C will be turned on in range states 2, 5 and 8. That of A2DS1A in range states 1, 4 and 7 and that of A2DS1B in range states 0, 3 and 6.

4-94 AC CONVERTER CONTROL LOGIC

4-95 The AC Converter has internal relays controlled by the ranging system. Table 4-2 shows the closure of the relays in certain range states. These control the internal attenuator in a manner similar to those of the DC input attenuator and are described as to detailed function in paragraph 4-107. Fig. 4-8 is a simplified logic diagram of the control circuits. In simplifying the diagram, any connections to gates or inverters that play no role in the control of the AC Converter are deleted. This results in what appears to be an unnecessary connection of two inverters in series. These inverters do, indeed, drive several other devices. Serially connecting the inverters satisfies the engineering fan-out limit. All of the logic outputs shown in this diagram, drive relays in the AC Converter whose purpose is explained in detail in paragraph 4-107.

4-96 OHMS CONVERTER CONTROL LOGIC

4-97 The OHMS Converter must be connected to the main frame in the OHMS mode of operation and its internal relays must be programmed in accordance with the conditions shown in Table 4-1 and Table 4-2. These functions are controlled by the ranging system and the logic for this control is shown in Fig. 4-9 in simplified form. The outputs of decoder A1IC32 will be low in their respectively numbered range states and the D output of counter A1IC6 will be high in range state 8 as it is binary number 8.

4-98 Closing the OHMS switch will make the inputs to NAND gates A1IC38A and A1IC37A high at all times. The output of NAND gate A1IC37A and $\overline{\Omega}$ will go low connecting the converter to the blue and yellow terminals on the front panel. The inputs to NAND gate A1IC34D will be high except in states 0 and 1. The output of A1IC34D and, therefore, the input to A1IC38A, will be high during states 0 and 1 forcing the output of A1IC38A low and $\overline{1} + \overline{10}$ low. The inputs to NAND gate A1IC28C will be high except in states 5 and 6. The $\overline{100K} + \overline{1M}$ line will then be low during state 5 and 6. The other four lines, $\overline{100}$, $\overline{1K}$, $\overline{10K}$ and $\overline{100M}$ will go low when the numbered range state at the output of A1IC32 goes low.

4-99 OHMS CONVERTER

4-100 The OHMS Converter schematic diagram is shown in Figure 6-9. It is essentially a constant current generator that applies a constant current to the blue and yellow front panel terminals of the instrument which then flows through the unknown resistance. The DC voltmeter measures the voltage drop across the unknown resistance and displays the voltage in terms of resistance. The DMM-42 measures a wide range of resistance values from a small fraction of an ohm to 200 megohms. To accomodate this wide range of measurements, not only must the constant current value be different for some ranges but the gain of the buffer amplifier must be changed as well. Table 4-1 shows the buffer gain used for each resistance range and paragraph 4-97 discussed the logic circuits that control the OHMS Converter.

4-101 The OHMS Converter has its own power supply located on the mainframe circuit board. A secondary winding on transformer A1T1 furnishes AC to a rectifier and filter system comprised of diodes A1CR5 through A1CR8, and capacitors A1C12 and A1C13. This power source is completely isolated from all other circuits. The unregulated supply voltages from the mainframe enter

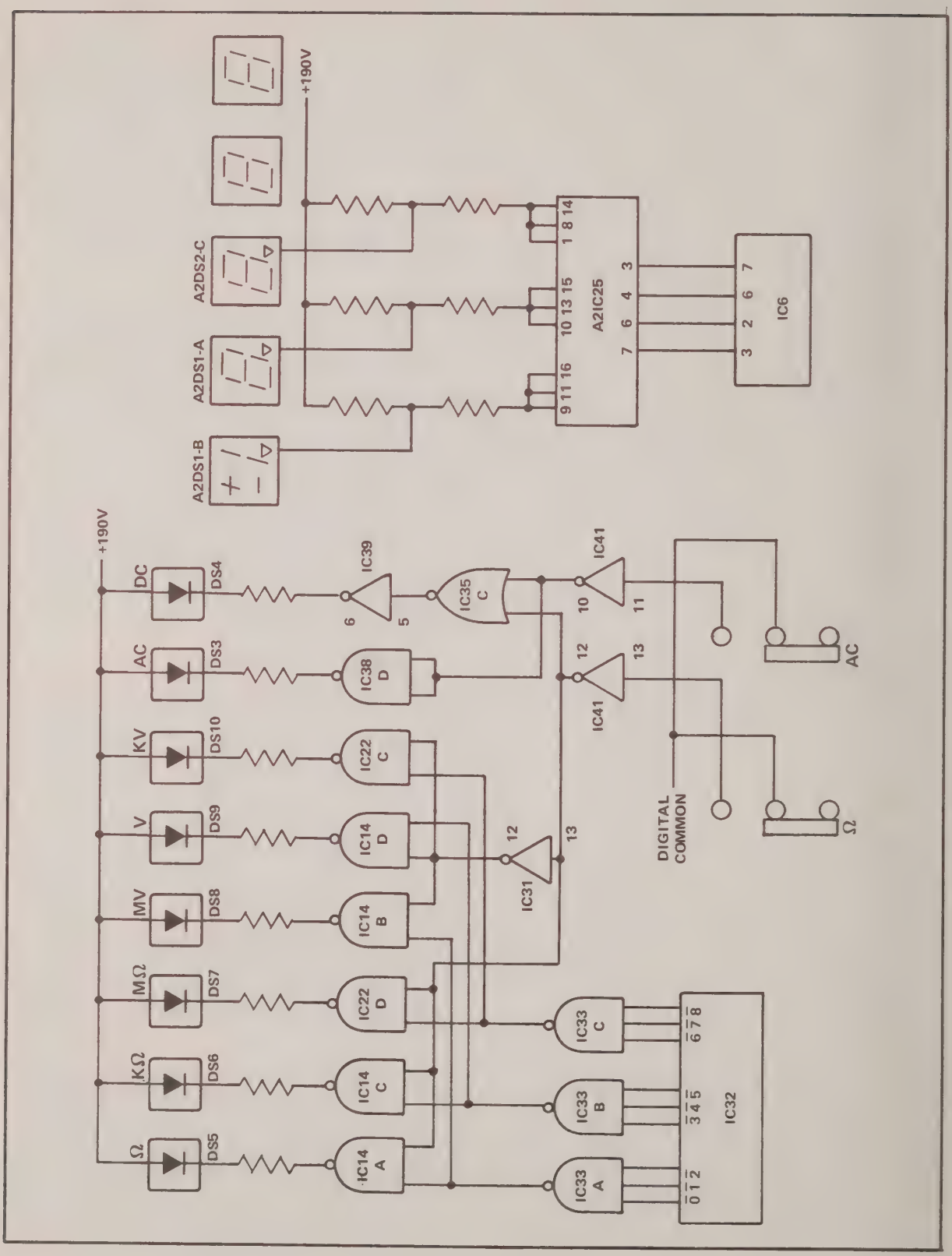


Figure 4-7. Annunciator and Decimal Control Logic Circuit.

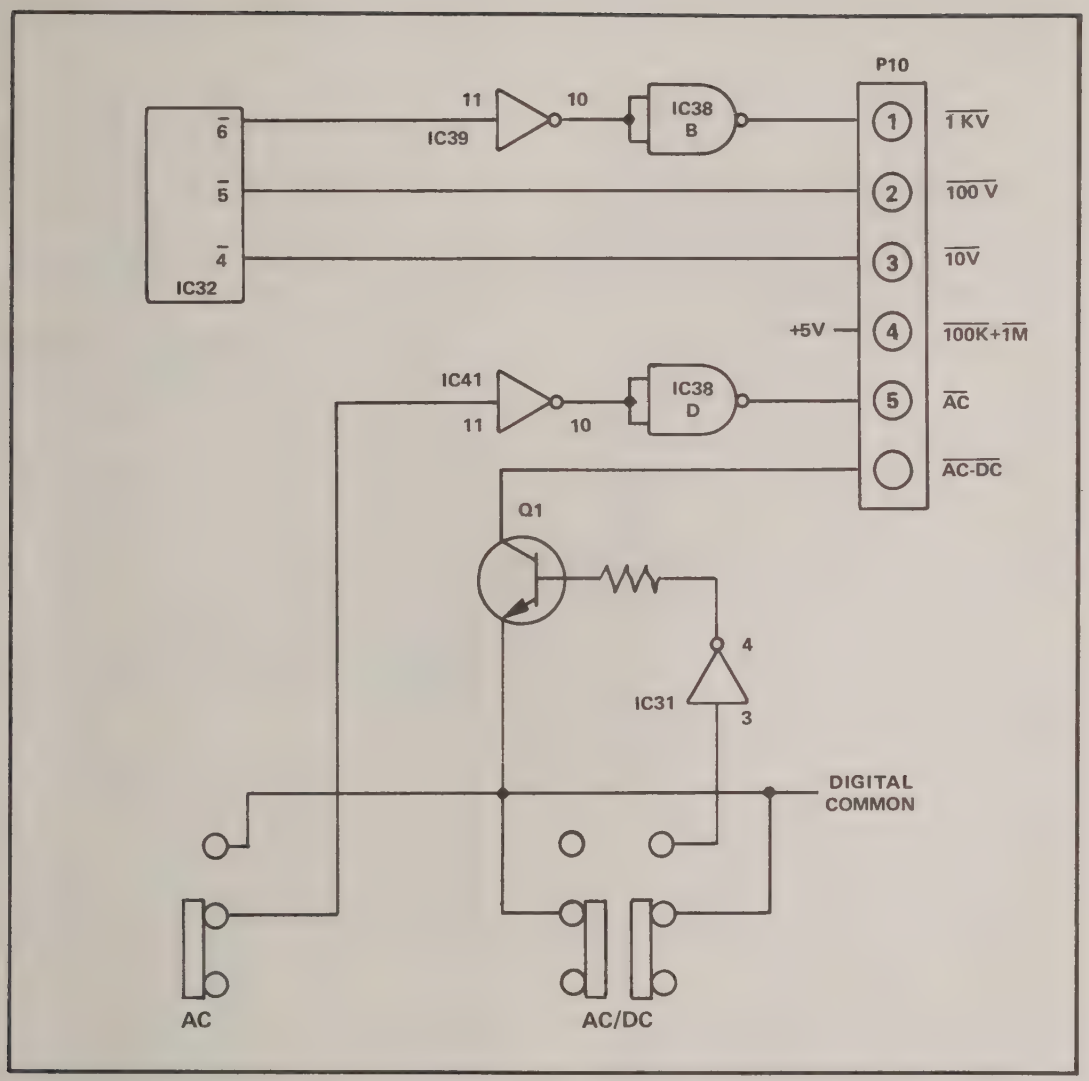


Figure 4-8. AC Converter Control Logic Circuit.

the converter at connector A4J12 and pass through two emitter follower regulators A4Q1 and A4Q2 to provide the regulated +15 volts and −15 volts required by the system. The −15 volt source is further regulated to −10 volts through A4IC2. This circuit is quite similar to the +10 volt reference regulator in Fig. 6-4. Resistor A4R28 and diode A4CR11 are a matched set and should be replaced only with a similar matched set supplied by the factory. Potentiometer A4R31 is the adjustment for the −10 volt output of amplifier A4IC2. The purpose of A4IC2 is to provide a fixed source of current for A4CR11.

4-102 The voltage at the junction of A4R28 and A4CR11 is −6.25 volts. This is applied to a voltage divider made up of A4R27, A4R17, A4R18, A4R19 and A4R20. When none of the range relays are energized, the potential at the arm of A4R17 is −1 volt which is applied to the input of operational amplifier A4IC1. With a resistor connected between A4J3 and A4J4, the current from common through A4R22 and A4R21 to the summing junction at terminal 2 of A4IC1 must be 100 nanoamps to balance the inputs to the amplifier. This current will be furnished by the output of the amplifier. When relay A4K7 is energized in the 100M ohm range, the voltage applied to the + input of A4IC1 will only be 0.1 volts. The current through A4R21 and A4R22 will then only be 10 nanoamps. The voltage developed across a 100M ohm resistor will then be the same as that across a 10M ohm resistor, however, the decimal point in the instrument display will have changed to indicate that the resistance is 100M ohms.

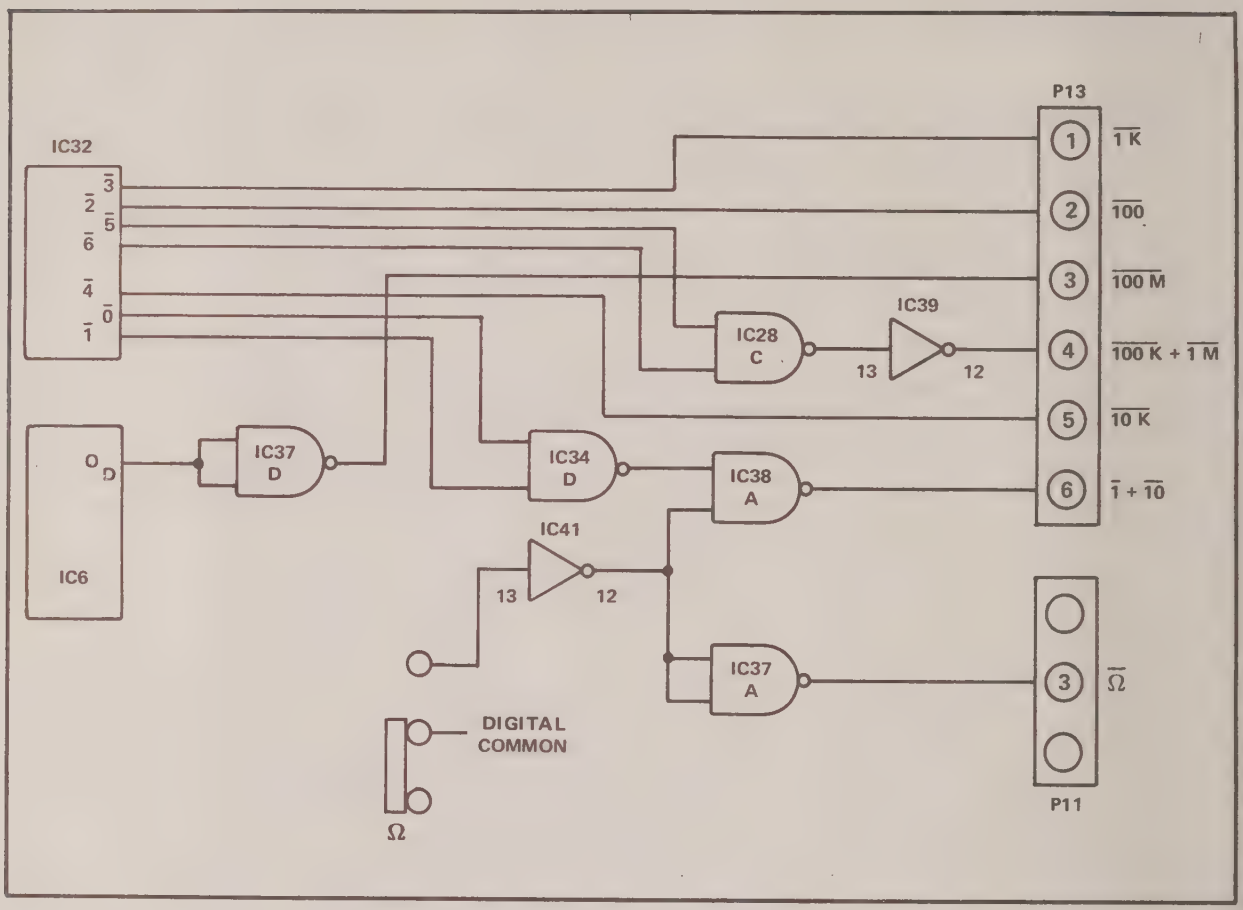


Figure 4-9. Ohms Converter Control Logic Circuits.

4-103 The other relays will close for the ranges shown along connector A4J13 and introduce lower resistances between the common line and the inverting input of the amplifier and, consequently, a higher current will be generated in those ranges. The relays are all of the reed type except A4K1, A4K2 and A4K7. A4K2 is an open relay with its two sets of normally open contacts wired in parallel to reduce contact resistance. Each of the ranges has an adjustment for which directions will be found in the maintenance section of this manual.

4-104 The circuit is protected against application of voltages up to 200 volts peak across the output terminals A4J3 and A4J4. If the applied voltage is positive at A4J3, one of the diode connected FET's across the inputs of A4IC1 will conduct. A4J4 will be negative and diode A4CR12 will not conduct protecting the input of the amplifier. With the reverse voltage applied, the other FET will conduct protecting the input. A4CR12 cannot provide protection as it will not conduct. However, transistor Q6 will limit the current flow. When the current through A4R25 causes the voltage drop to approach 0.65 volts, the base to emitter voltage will drop and additional current cannot be forced through Q6. Relay A4K1 disconnects the constant current source from the output terminals when the unit is in the DC or AC mode of operation.

4-105 AC CONVERTER

4-106 The AC Converter is an amplifier-rectifier system with input attenuation automatically controlled by the ranging system. It furnishes a DC voltage to the input of the mainframe buffer amplifier in the range of 0-2 volts. There is no gain change in the buffer amplifier during AC operation. The mainframe annunciator and the decimal points in the display are coordinated with the AC converter input attenuator so that the readout is in terms of the input voltage. Refer now to Fig. 6-7. Relay A3K1

completes the connection between A3J8 terminals 1 and 3 during DC and OHMS operation. This completes the connection between the input terminals and the mainframe input attenuator. In the AC mode, A3K1 is energized connecting the input terminals to the input of the AC Converter and the output of the AC Converter to the mainframe input. From terminal 13 of A3K1, the input signal is routed through A3C1 and A3R1 to the input of FET A3Q1 which is the AC summing junction. The capacitors in parallel with A3R1 are high frequency compensators. Adjustment of A3C2, as well as other variable capacitors in the AC Converter, is covered in Section V. Diodes A3CR1 through A3CR6 provide overvoltage protection for A3Q1. A3Q1 operates as a source follower and drives transistor A3Q2 which in turn drives the guard shield reducing the input capacity of the converter. A3Q1 also drives amplifier A3IC1. A3R17 and A3R12 provide DC feedback for stability and A3C10 provides a long time constant for this loop. A3CR11 and A3CR12 are hot carrier diodes with low voltage drop. The path back to the summing junction at the gate of A3Q1 is from the common junction of A3R18, A3R19 and A3R20 and through A3R2 and A3R3. A3R2 provides the low frequency adjustment and A3C5 the high frequency adjustment.

4-107 Attenuation for the several ranges of input is obtained by connecting resistance in parallel with A3R2 and A3R3 by means of relays A3K2, A3K3 and A3K4 thereby increasing the feedback from the output of the amplifier to the AC summing junction and reducing the gain accordingly. The AC amplifier will operate open loop between the limits of +0.3 volts and –0.3 volts at the output of A3IC1 due to the threshold of the diodes. This will cause the slight distortion of the waveform as shown in Fig. 6-7. Diodes A3CR12 and A3CR11 rectify the output of A3IC1 developing negative and positive voltages respectively which are then applied to the two inputs of amplifier A3IC2 after being filtered by the RC networks in each leg. A3IC2 is a differential amplifier that will have a DC output proportional to the difference between its two inputs which are differentially proportional to the AC input voltage. A3R24 establishes feedback to the input to maintain the gain of the amplifier at approximately 1. A3R30 is the output adjustment and is set for exactly 1 volt out with 1 KV input. COM #1 at terminal 6 of connector A3J9 is the signal ground whereas COM #2 is the DC ground. These are joined together at the mating plug on the mainframe circuit board.

4-108 EXTERNAL EQUIPMENT CONNECTIONS – (Fig. 6-4)

4-109 The CIMRON Model DMM-42 Digital Multimeter may be used in a system where voltages and resistances are measured on a selected or programmed basis from a remote point and/or recorded or used as a computer input. The connections for the remote control point are available at rear panel connector A1J6. When the REMOTE switch is depressed, the front panel switches, except the UP and DOWN switches, are rendered inoperative and control is transferred to equipment connected to A1J6. Connecting terminal 26 of A1J6 back to terminal 49, or 50, sets the unit in the manual range mode. Manual control is established when this connection is made and the desired range selected by grounding terminals 6, 7, 9 and 10. These four terminals are connected to the parallel load lines of the up-down counter, A1IC6, through individual inverters. Each has a binary weight and when grounded individually, or in combination, will command the range state corresponding to the binary number represented by the grounded lines. For example, grounding terminals 7 and 10 would command range state 6. The external control must be interlocked to prevent commanding a range state inappropriate to the mode of operation. Range state 1, for instance, must not be commanded when the unit is in the DC or AC mode of operation. The output lines of A1IC6 are connected to terminals 11 through 14 and may be used with suitable interface equipment to indicate at the remote control location which range state is in operation. The mode of operation desired, DC, AC or OHMS, is selected by grounding the appropriate terminal for AC or OHMS and leaving all terminals ungrounded for DC operation. The $\overline{\text{AC-DC}}$ line is not used except when the RMS converter is installed. Terminals 4, 5 and 47 provide a signal to the remote control location as to the mode of operation in use. Terminal 20 carries polarity information from the output of quad latch A1IC1. Terminal 19 indicates to remote equipment that the data is ready to be recorded. This signal goes high when the range is correct and the data has been displayed on the front panel indicators. $\overline{\text{HOLD}}$ at terminal 46, when grounded, will disable A1IC13 stopping the clock and all functions until the ground is removed. The data is transmitted to the remote control location in binary form. The output lines from quad latches A1IC1 through A1IC5 are connected to individual terminals of A1J6 through inverters which provide buffering. Terminal 11 of A1IC1 goes to a low state when the count exceeds 19,999 and through inverter A1IC8-12 goes high at terminal 27 of A1J6 signalling an out-of-range condition. Terminal 28 is high when A2DS1 displays a 1. Terminal 48 provides 20 ma. of current at 5 volts to the remote equipment. The common terminals are 49 and 50 and provide a common ground connection between the remote equipment and the DMM-42.

SECTION V
MAINTENANCE

5-1 GENERAL

5-2 This section of the manual contains instructions for periodic maintenance, calibration, troubleshooting and repair of the Model DMM-42 Digital Multimeter.

5-3 TEST EQUIPMENT

5-4 The test equipment required for adjusting and troubleshooting the DMM-42 Digital Multimeter is listed in paragraph 5-15.

5-5 PREVENTATIVE MAINTENANCE

5-6 Careful and regular performance of periodic preventative maintenance will reduce the probability of failure and the need for corrective maintenance.

5-7 INSPECTIONS

5-8 Perform periodic inspections as follows:

PERIOD	AREA OF INSPECTION	ITEMS TO BE CHECKED
Weekly	Exterior of unit, particularly front and rear.	Controls indicators and connectors for dust and dirt, security of mounting or connection, signs of damage.
Quarterly	Interior of unit including OHMS and AC converters	Electrical parts and wiring (including printed circuit wiring) for dust, dirt, corrosion and evidence of overheating and other damage. Due to the high voltage used in this area, particular attention should be paid to the area around the display circuit board for the accumulation of dust.

5-9 CLEANING

5-10 Remove dust, dirt, and other foreign material using a small brush and vacuum cleaner. Low pressure air may be used if a vacuum cleaner is not available. When using the air, be sure to aim the air stream so that the foreign material will be blown out of the unit rather than into recesses, slots, etc. Use a cloth and a suitable solvent to remove material not removable by means of the above procedure.

CAUTION

Take care not to scratch the printed circuit wiring if it is necessary to brush or rub it to remove foreign material. Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzine, toluene, xylene, acetone or similar solvents. If solvent is used, allow all areas to thoroughly air dry prior to placing instrument in use.

5-11 LUBRICATION

5-12 No lubrication is required.

5-13 PERFORMANCE TEST

5-14 The performance test consists of removing normal inputs to the multimeter and performing the acceptance tests of paragraph 2-15 of this manual.

5-15 TEST EQUIPMENT REQUIRED

5-16 The test equipment required to trouble shoot or calibrate the DMM-42 Digital Multimeter is listed in Table 5-1.

Table 5-1. Required Test Equipment

ITEM	MFR. AND MODEL NO.	TOLERANCE
DC Voltage Standard	COHU 351 or equivalent	
AC Voltage Standard	HP 745/746 or equivalent	
Four-Terminal Resistance Standards	Decade values from 1 ohm to 100 megohms	±0.005%
Variable output transformer	Superior Electric Model 216 Variac or equivalent	

5-17 TROUBLESHOOTING

WARNING

HIGH VOLTAGE (200 VDC)

This equipment is powered by and generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with all input power connections, the high voltage power supply and display modules. Verify that power supply voltages are discharged to safe levels before touching circuitry.

CAUTION

Maintenance should be attempted only by qualified electronic technicians with some training in digital logic techniques and only after a thorough study of the principles of operation described in detail in Section IV.

5-18 As an aid to trouble shooting of the DMM-42 Digital Multimeter, several trouble shooting flow charts have been included in this section. Each deals with a particular type of malfunction. By following the step-by-step procedures therein, the malfunctioning circuit can be isolated. It is recognized that all possible failure modes cannot be anticipated. The technician will be well advised, therefore, to make a thorough study of the principles of operation described in detail in Section IV. The troubleshooting flow charts are listed below in Table 5-2. Trouble shooting will be facilitated by reference to the simplified logic diagrams of Section IV.

Table 5-2. List of Troubleshooting Flow Charts

CHART NO.	TEST SERIES	MALFUNCTION
I	A	Display will not light.
II	B-1	Display locked up, not blinking
III	B-2	Display locked up, blinking
IV	C	Analog circuit lockup
V	D	Inaccurate DC reading
VI	E	Improper ranging
VII	F	OHMS converter malfunction
VIII	G	AC converter malfunction

CHART I
TEST SERIES A
DISPLAY WILL NOT LIGHT

Note: All DC voltage measurements on this chart are referenced to Digital common (top of 4000 Mfd. capacitor next to transformer A1T1)

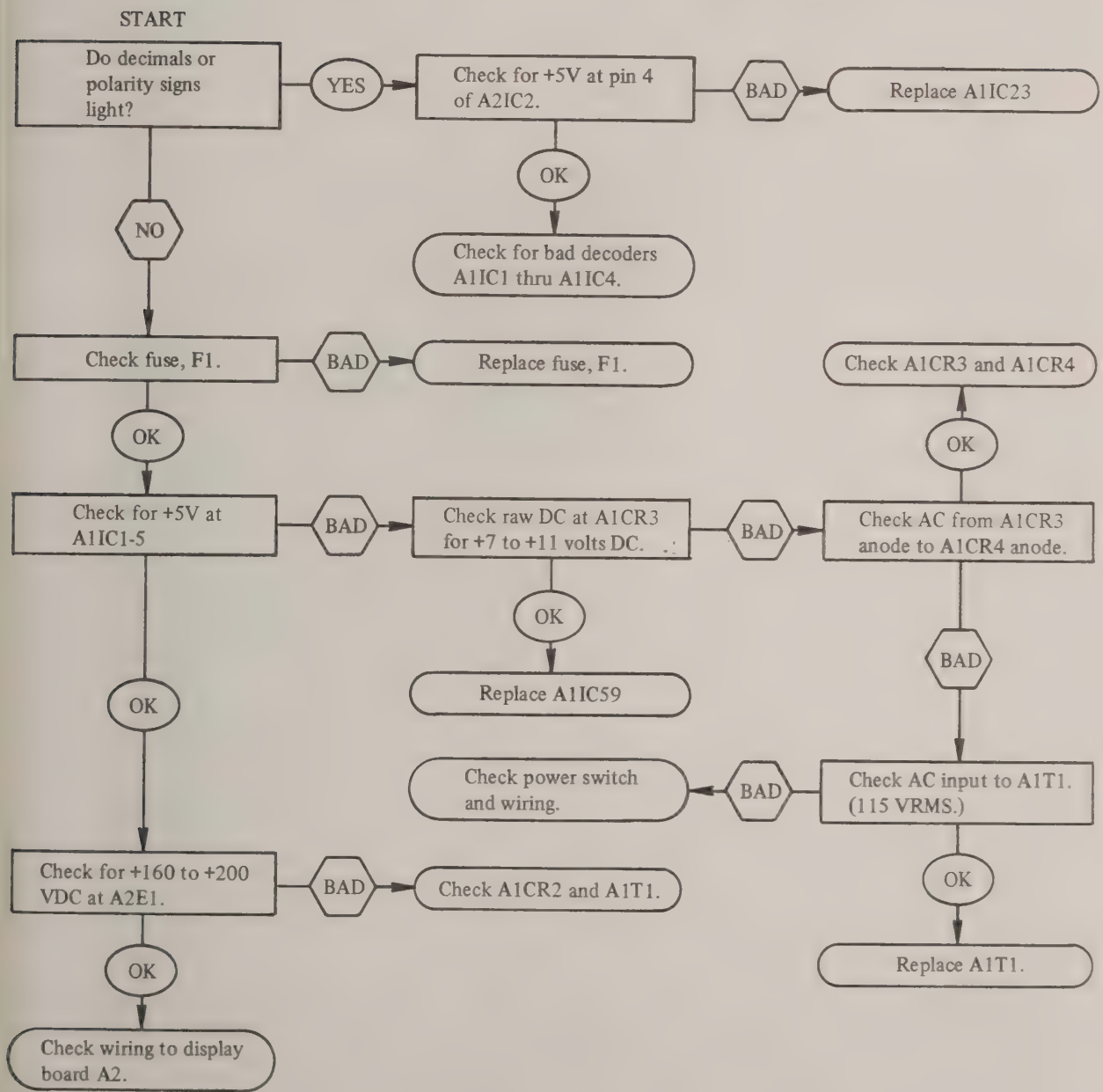


CHART II
TEST SERIES B-1
DISPLAY LOCKED UP-NOT BLINKING

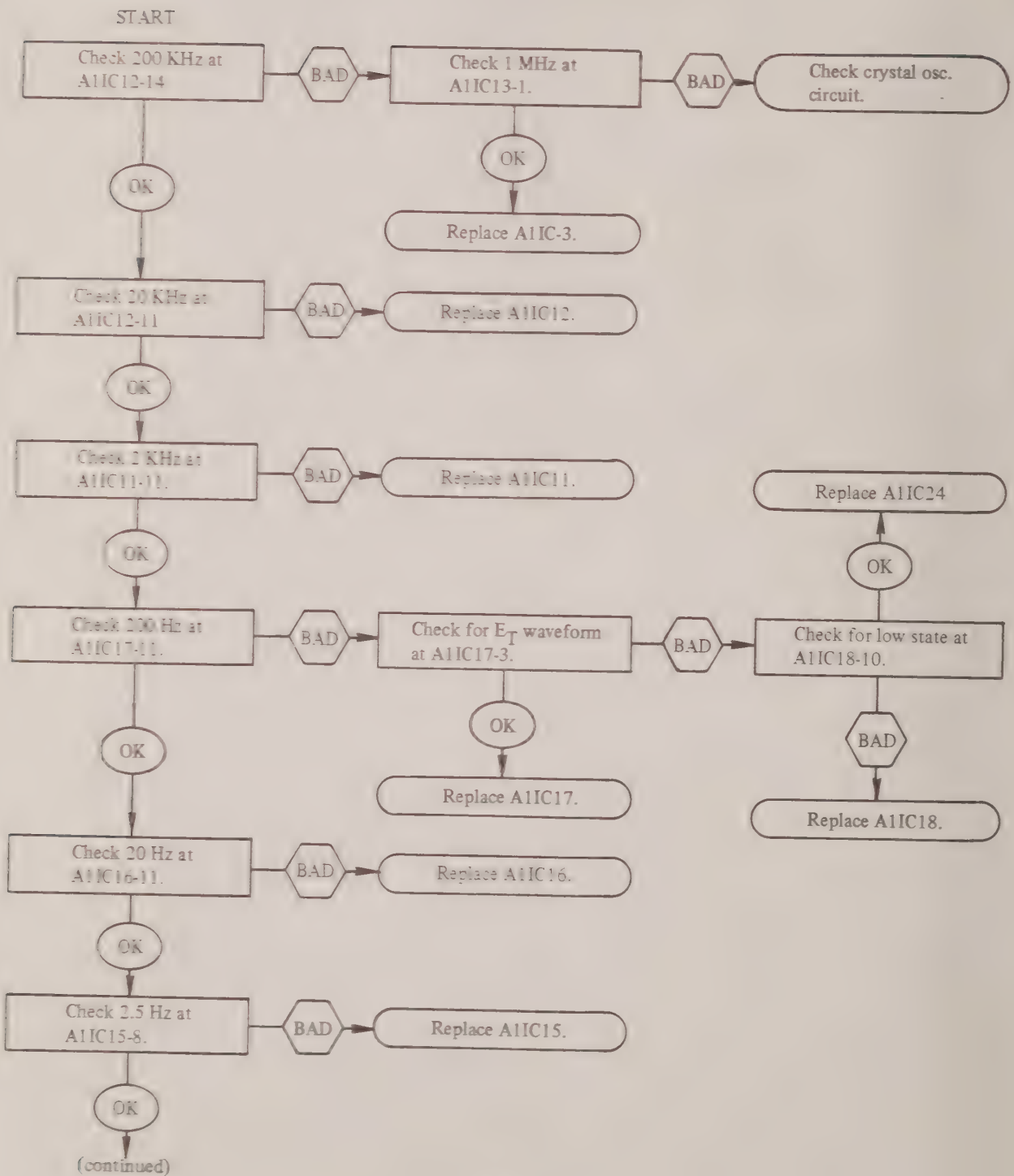


CHART II continued

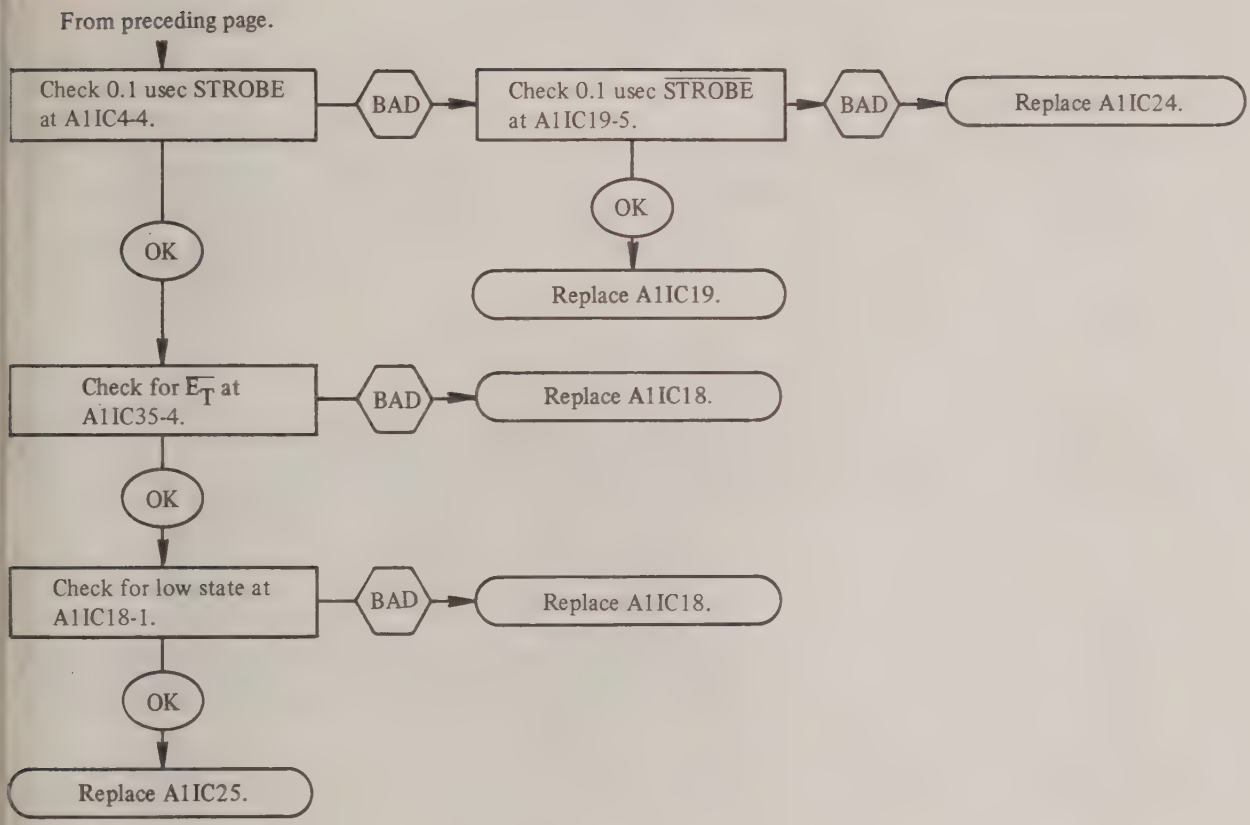


CHART III
TEST SERIES B-2
DISPLAY LOCKED UP-BLINKING

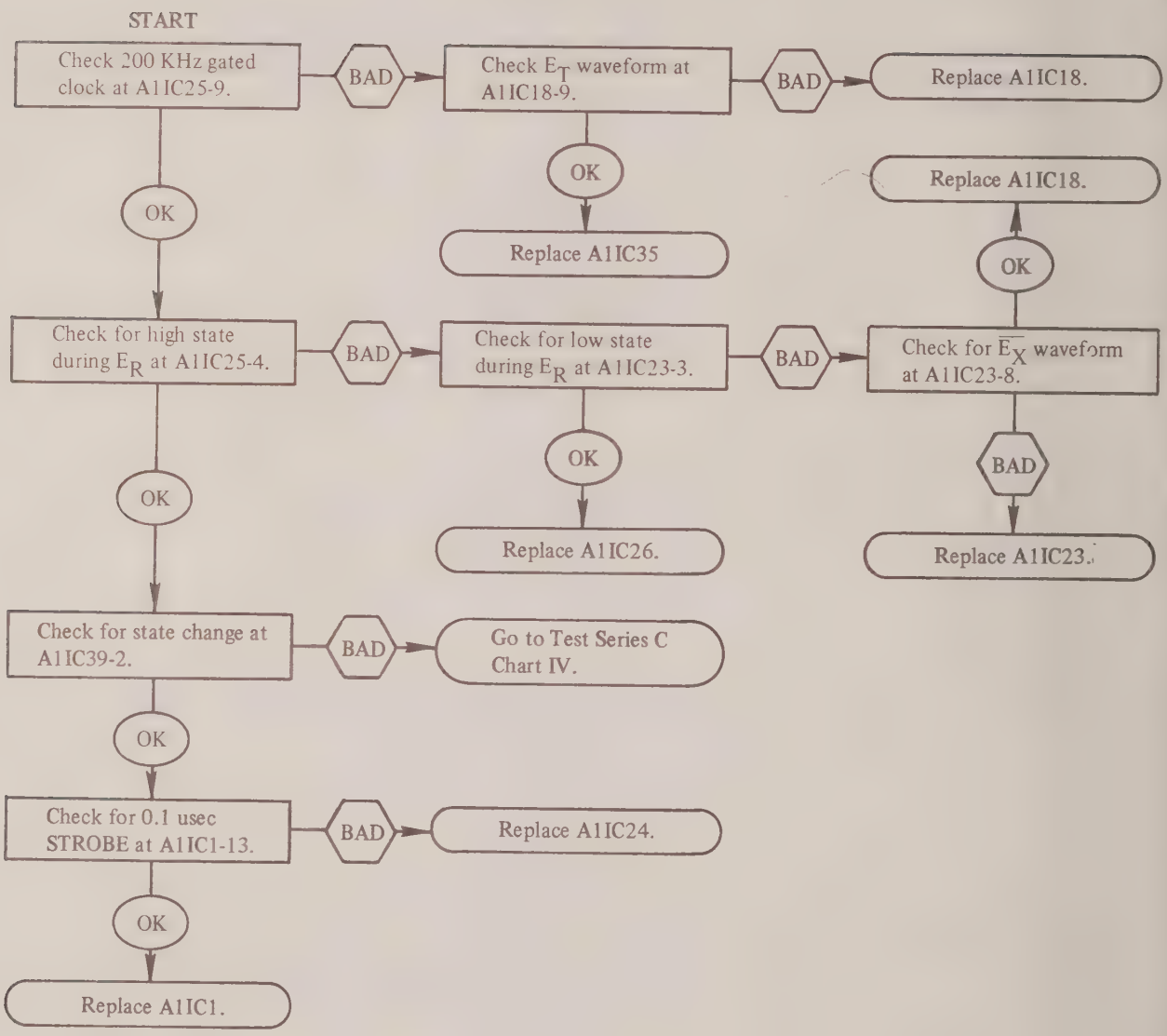


CHART IV
TEST SERIES C
ANALOG LOCKUP

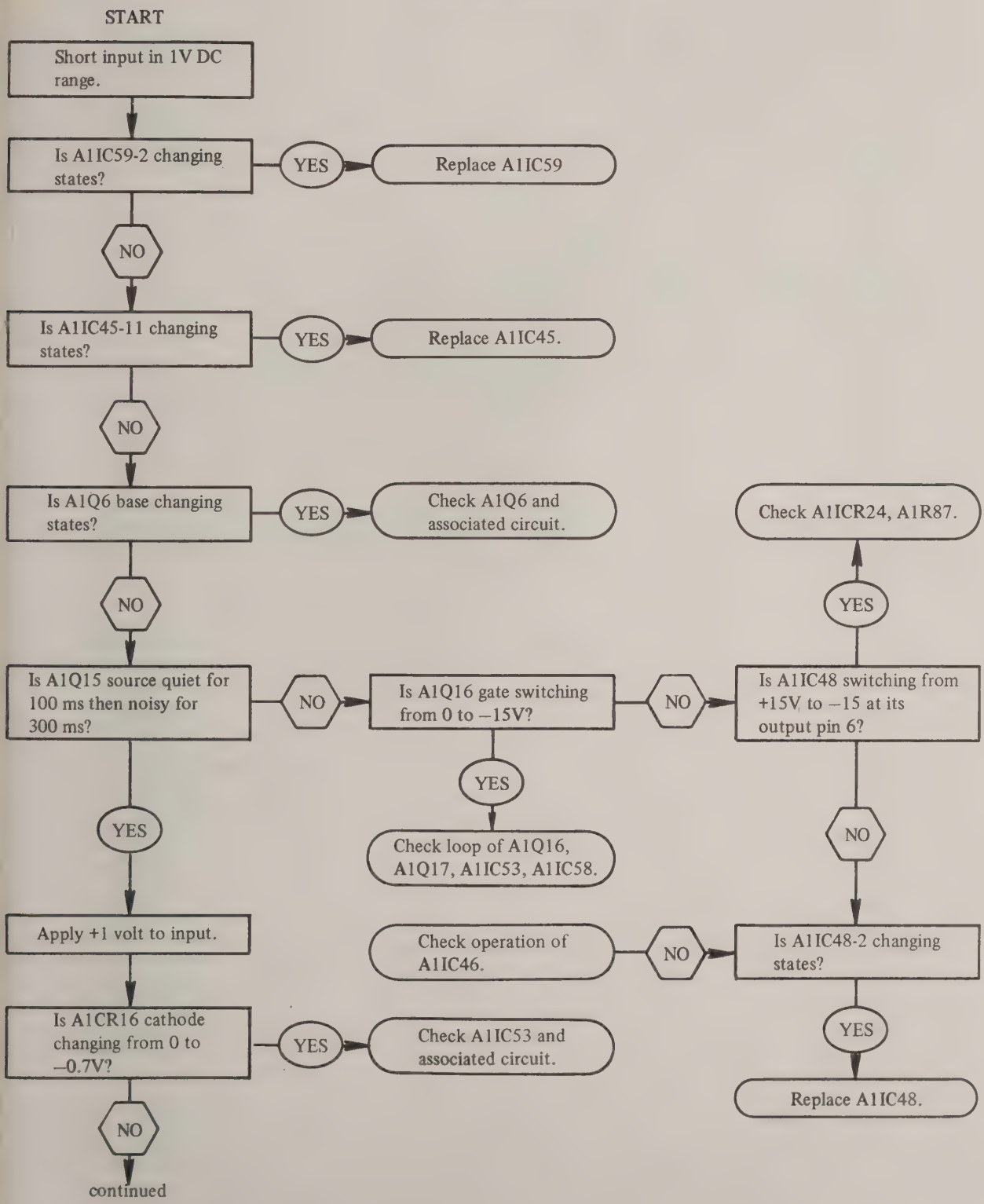


CHART IV Continued

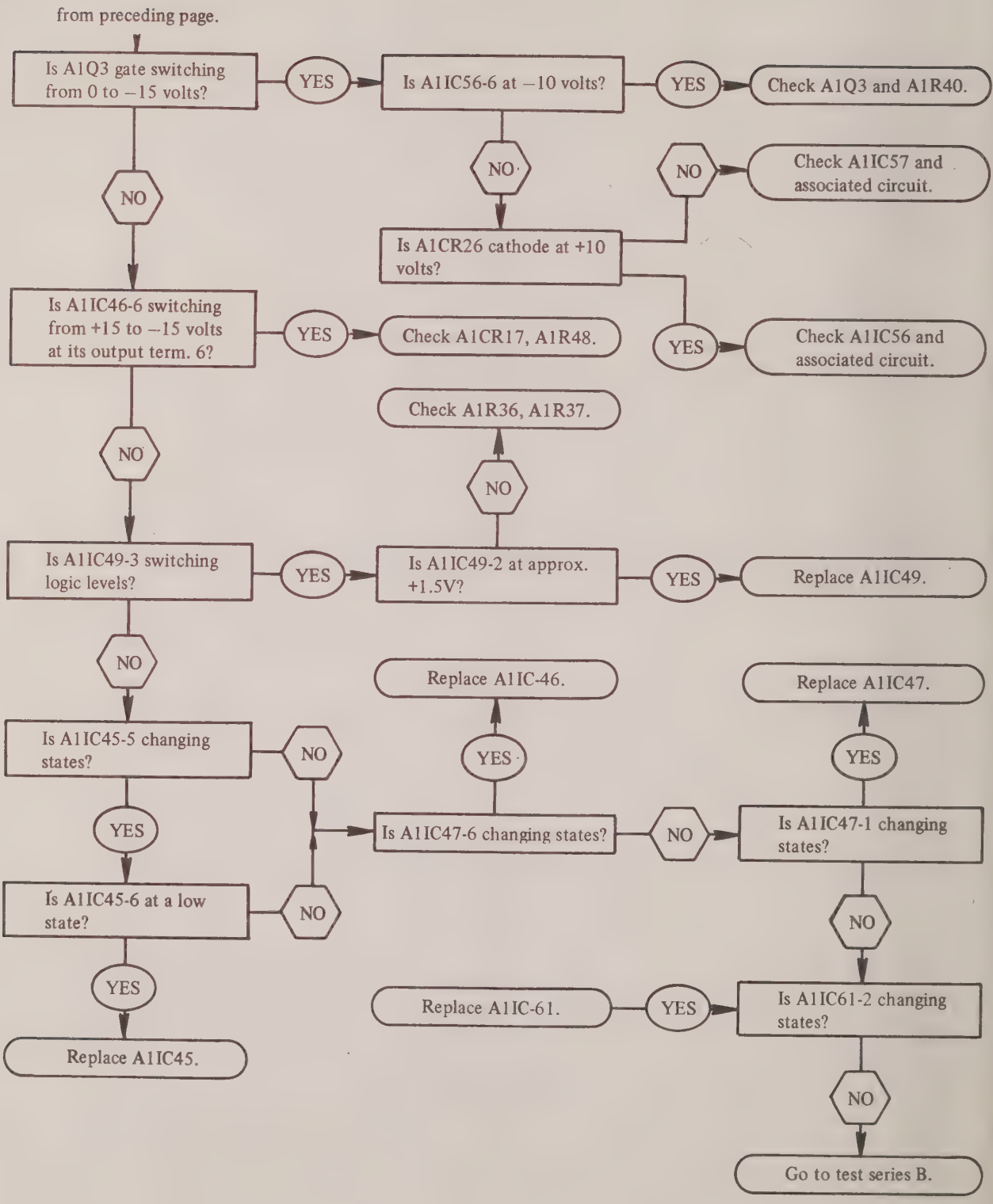
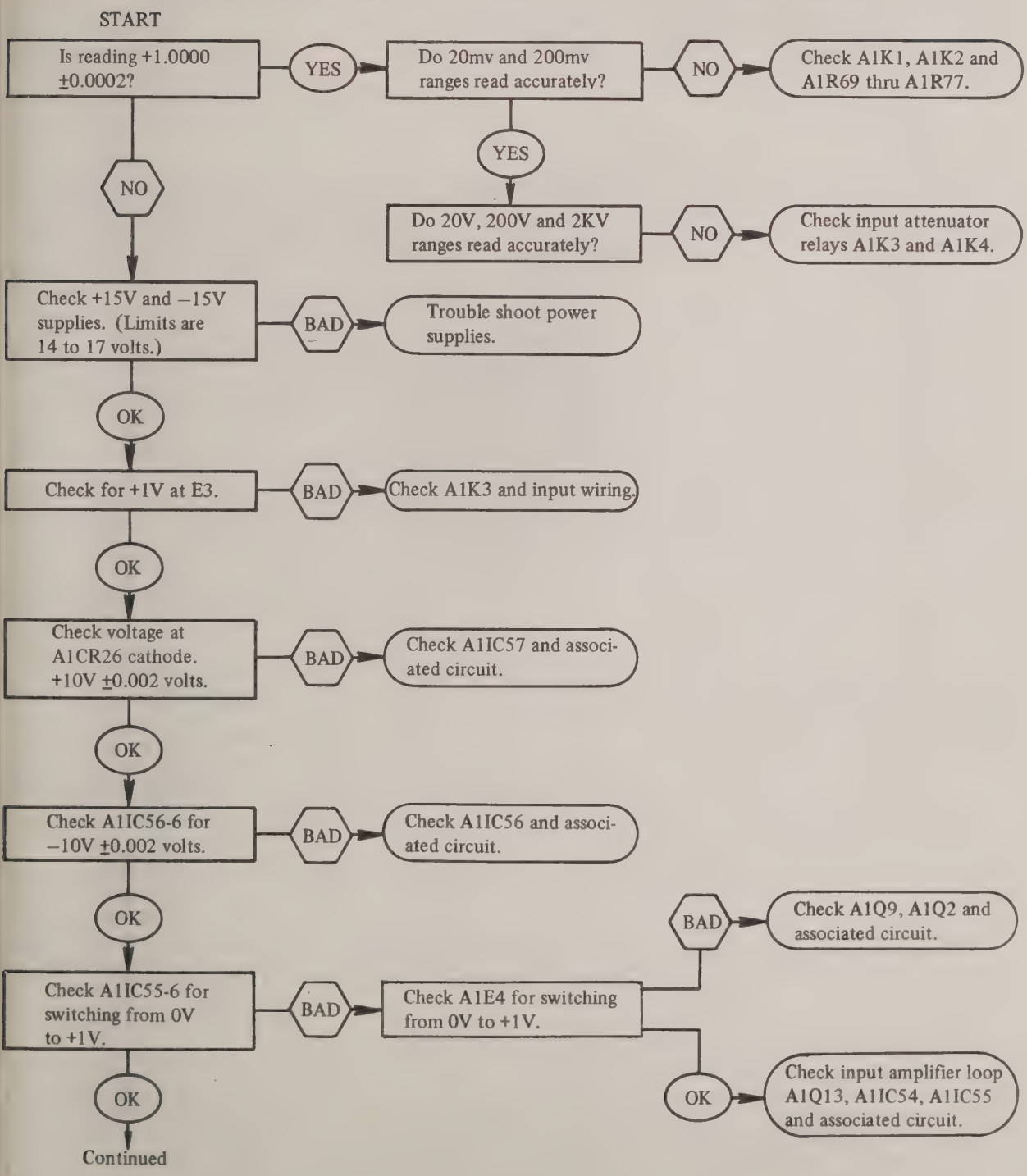


CHART V
TEST SERIES D
INACCURATE DC READING

Note: Select DC function and 2 volt range. Apply +1.0000 volts to input terminals.



From preceding page.

CHART V Continued.

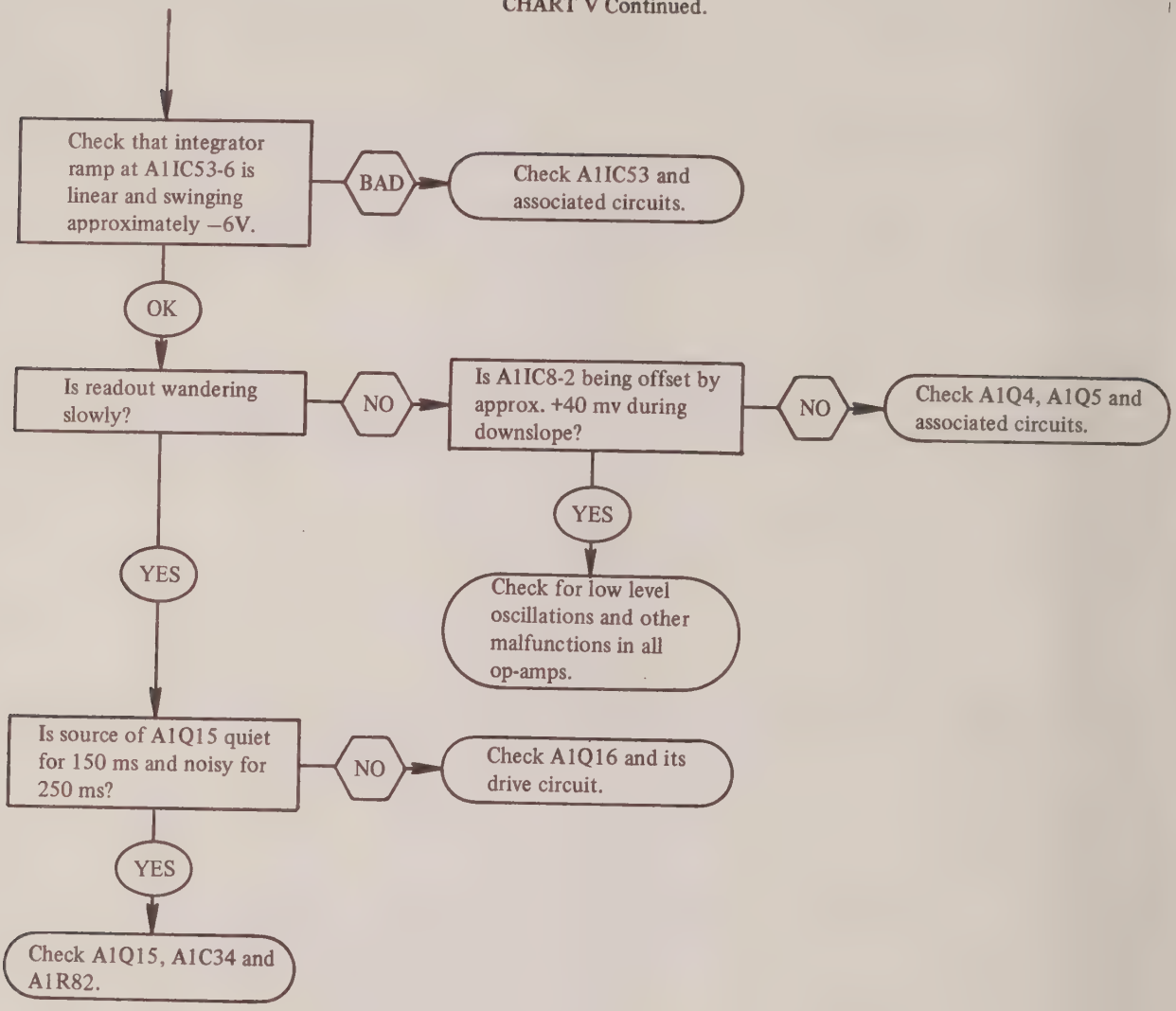

Check that integrator ramp at A1IC53-6 is linear and swinging approximately −6V.
BAD
Check A1IC53 and associated circuits.
OK
Is readout wandering slowly?
NO
Is A1IC8-2 being offset by approx. +40 mv during downslope?
NO
Check A1Q4, A1Q5 and associated circuits.
YES
Check for low level oscillations and other malfunctions in all op-amps.
YES
Is source of A1Q15 quiet for 150 ms and noisy for 250 ms?
NO
Check A1Q16 and its drive circuit.
YES
Check A1Q15, A1C34 and A1R82.

CHART VI
TEST SERIES E
IMPROPER RANGING

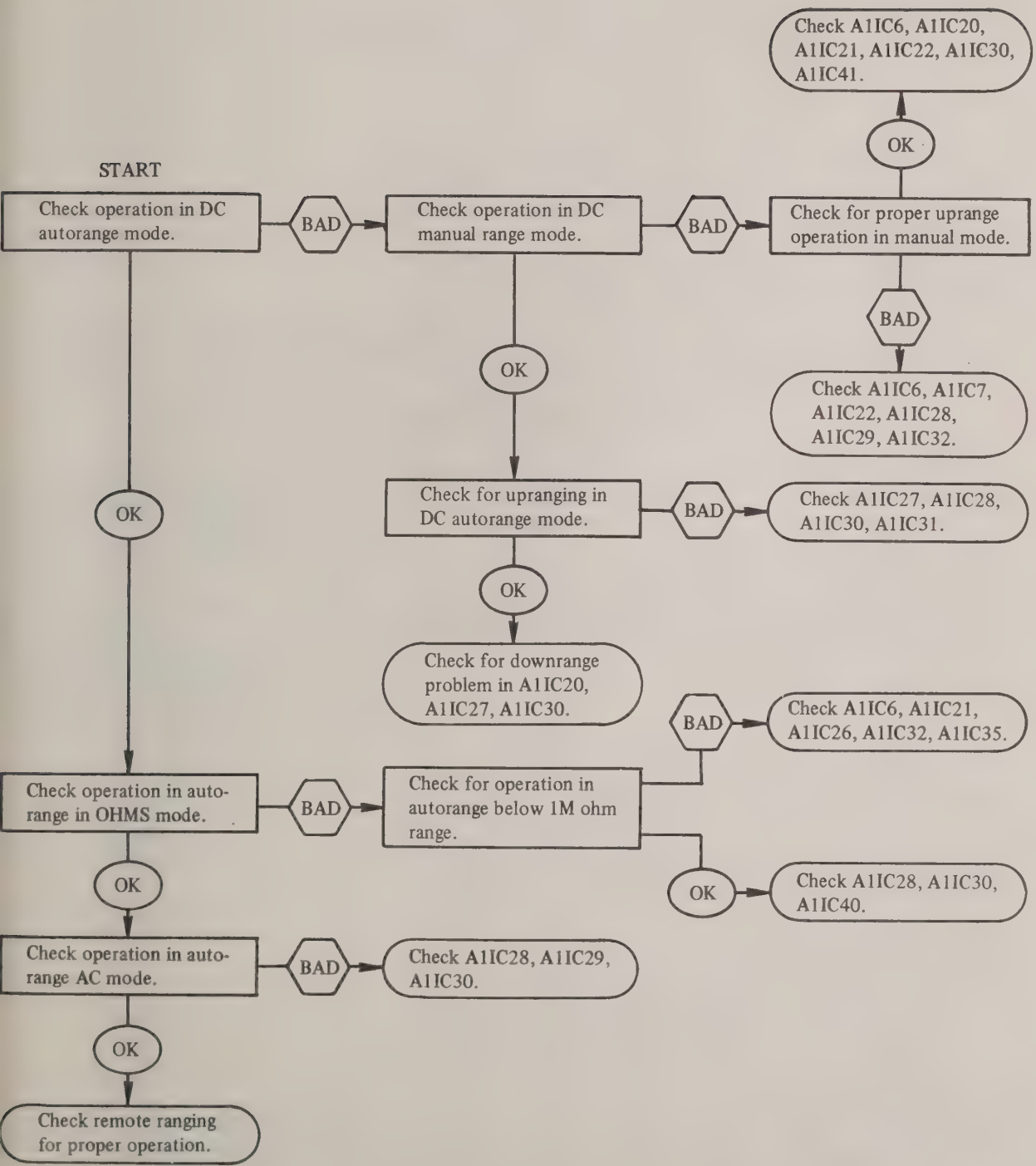


CHART VII
TEST SERIES F
OHMS CONVERTER MALFUNCTION

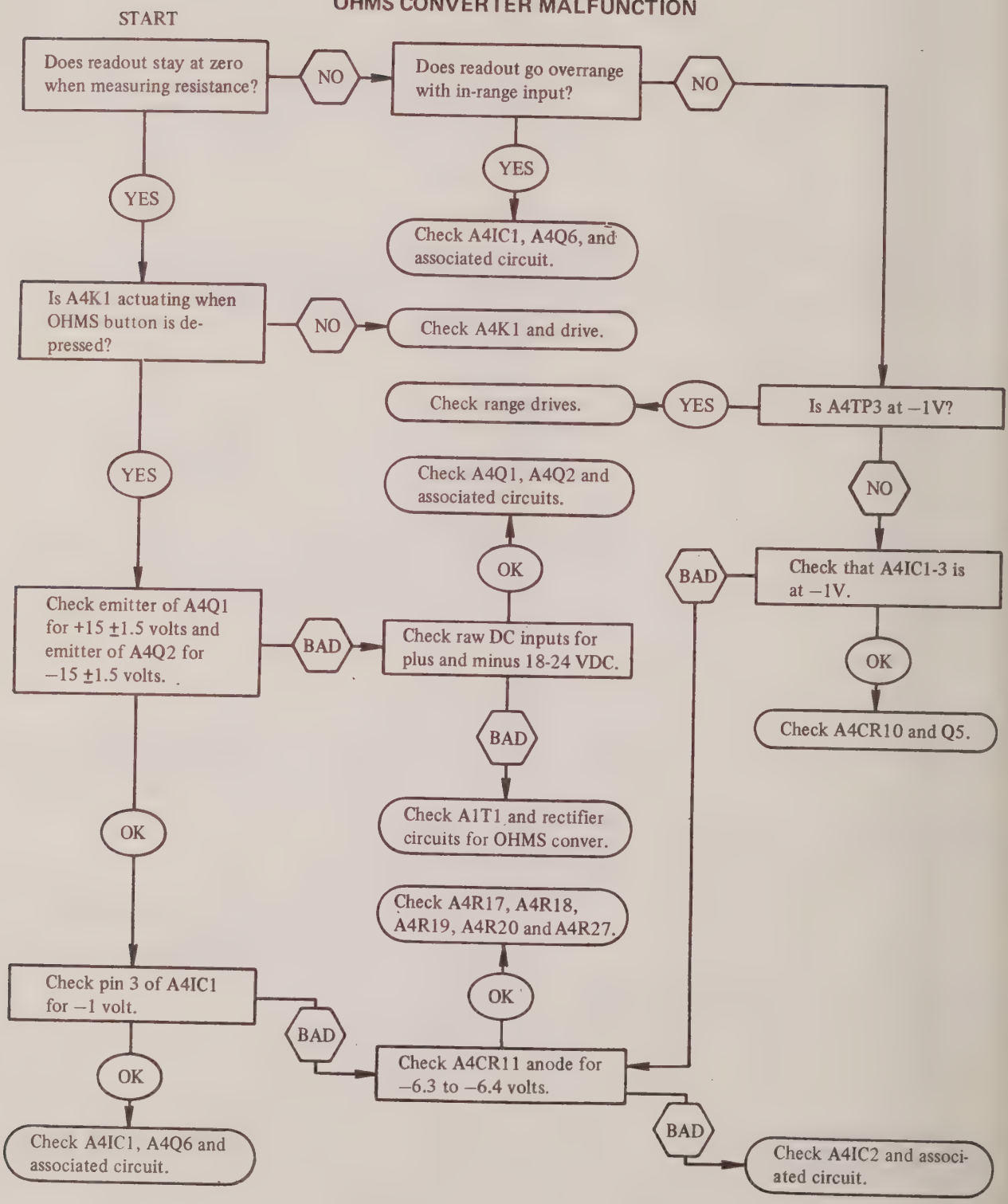
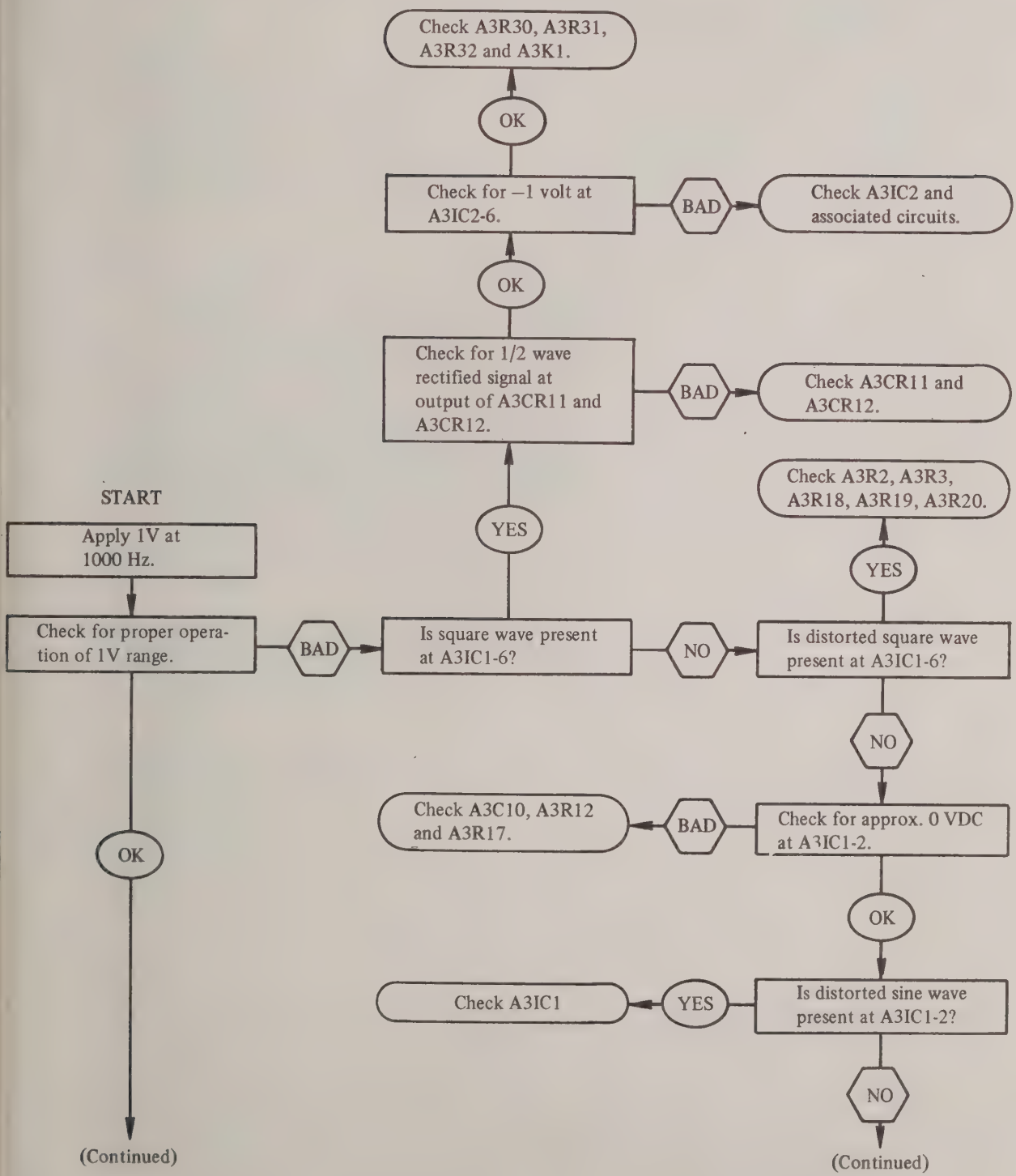
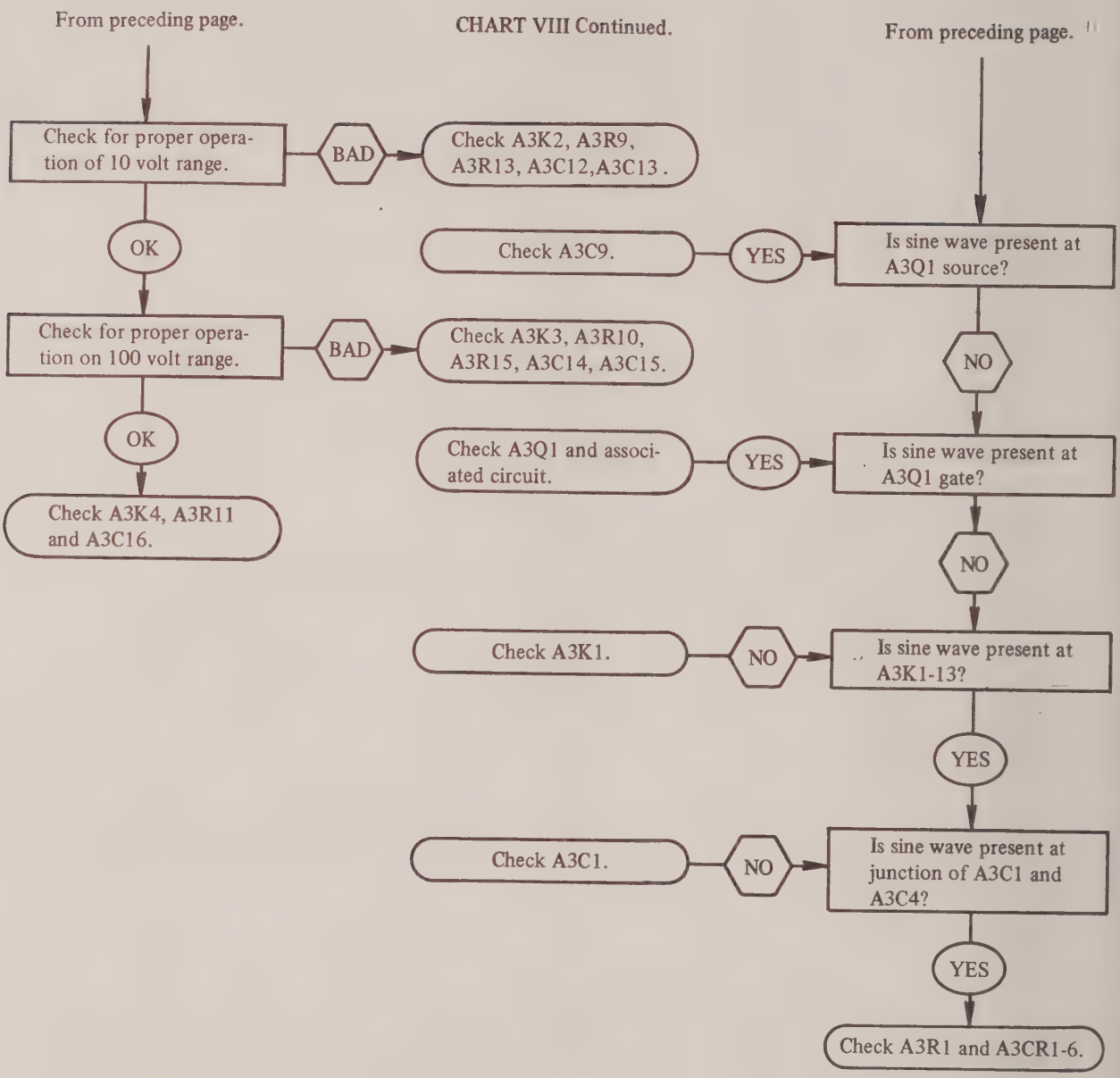


CHART VIII
TEST SERIES G
AC CONVERTER MALFUNCTION




From preceding page.
CHART VIII Continued.
From preceding page.
Check for proper operation of 10 volt range.
BAD
Check A3K2, A3R9, A3R13, A3C12,A3C13 .
OK
Check A3C9.
YES
Is sine wave present at A3Q1 source?
Check for proper operation on 100 volt range.
BAD
Check A3K3, A3R10, A3R15, A3C14, A3C15.
NO
OK
Check A3Q1 and associated circuit.
YES
Is sine wave present at A3Q1 gate?
Check A3K4, A3R11 and A3C16.
NO
Check A3K1.
NO
Is sine wave present at A3K1-13?
YES
Check A3C1.
NO
Is sine wave present at junction of A3C1 and A3C4?
YES
Check A3R1 and A3CR1-6.

5-19 CALIBRATION PROCEDURE

5-20 The calibration procedures below require the test equipment listed in Table 5-2. Wherever voltages or resistances are specified in the following procedures, they are to be precise and within the tolerance specified in Table 5-2. Remove the top cover of the instrument and locate A1R55, A1C21, A1R45, A1R48, A1R93, A1R97, A1R75, A1R73, A1R104 and A1R106. These will be used for adjusting the DC voltmeter section and in the order shown. The adjustments for the AC converter and the OHMS converter are accessible through their respective covers and the component number is listed adjacent to the access hole.

5-21 DC CALIBRATION

5-22 Perform steps A and B only if A1Q13 in the input buffer amplifier has been replaced or if components ahead of the buffer amplifier have been changed.

A. Short the input terminals, select DC mode and the 2 volt range. Connect a DC coupled oscilloscope to the output of the input amplifier, A1IC55-6. Set oscilloscope for 100 mv/cm and center trace. Select the 20 mv range on the DMM-42. Adjust A1R64 to return the oscilloscope trace to center.

B. Short the input terminals, select the DC mode and the 20 mv range. Adjust OFFSET for polarity sign change. Select 20 volt range and adjust A1R117 for polarity sign change.

1. Select the DC mode and the 20 mv range. Short the input terminals and adjust OFFSET for a polarity sign change.

2. Select the 20 mv range and connect a 1 megohm, ±5% resistor across the input terminals and adjust A1C21 for a polarity sign change.

3. Repeat steps 1 and 2 as required.

4. Select the 2 volt range and apply +1.00 mv to the input terminals and adjust A1R45 for a display reading of +.0010.

5. Select the 2 volt range and apply −1.00 mv to the input terminals and adjust A1R48 for a display reading of −.0010.

6. Select the 2 volt range and apply −1 volt to the input terminals and adjust A1R93 for a display reading of −1.0000.

7. Select the 2 volt range and apply +1 volt to the input terminals and adjust A1R97 for a display reading of +1.0000.

8. Select the 20 mv range and alternately apply +10 mv and −10 mv to the input terminals. Adjust A1C21 and A1R55 (OFFSET) to balance the reading of the two inputs.

9. Apply +10 mv to the input terminals and adjust A1R75 for a display reading of +10.000.

10. Select the 200 mv range and apply +100 mv to the input terminals and adjust A1R73 for a display reading of +100.00.

11. Select the 20 volt range and apply +10 volts to the input terminals and adjust A1R104 for a display reading of +10.000.

12. Select the 1 KV range and apply +1000 volts to the input terminals and adjust A1R106 for a display reading of +1.0000.

Note: The 200 volt range is slaved to the 20 volt range and needs no separate adjustment.

5-23 AC CALIBRATION

5-24 1. Short the input terminals together, select the AC mode of operation and the 2 volt range. Adjust A3R29 for a display reading of .0000.

2. Select the 1 KV range and apply 1000 volts at 500 Hz to the input terminals. Adjust A3R31 for a display reading of 1.0000 ±1 digit.

3. Apply 400 volts at 50 KHz to the input terminals. Adjust A3C2 for a display reading of .40000 ±1 digit.

4. Select the 2 volt range and apply 1 volt at 500 Hz to the input terminals. Adjust A3R2 for a display reading of 1.0000 ±1 digit.

5. Apply 1 volt at 50 KHz to the input terminals. Adjust A3C5 for a display reading of 1.0000 ±1 digit.

6. Select the 20 volt range and apply 10 volts at 500 Hz to the input terminals. Adjust A3R13 for a display reading of 10.000 ±1 digit.

7. Apply 10 volts at 50 KHz to the input terminals. Adjust A3C12 for a display reading of 10.000 ±1 digit.

8. Select the 200 volt range and apply 100 volts at 500 Hz to the input terminals. Adjust A3R15 for a display reading of 100.00 ±1 digit.

9. Apply 100 volts at 50 KHz to the input terminals. Adjust A3C14 for a display reading of 100.00 ±1 digit.

5-25 OHMS CONVERTER CALIBRATION

5-26 A. Select the DC function, autorange and short the Yellow and Blue input terminals together. Connect the DMM-42 Black input terminal (Common) to A4TP2 of the OHMS Converter. Connect the Red input terminal (HI) to A4TP1. Adjust A4R31 for a display reading of −10 volts ±5 mv. Now, connect the Red input terminal to summing junction A4TP3 and adjust A4R17 for −1 volt ±1 mv.

Note: This calibration step is not part of the normal calibration procedure and need only be accomplished if a component of the OHMS Converter has been replaced.

1. Select the OHMS mode of operation and the 20 megohm range. Connect a 10 megohm resistor across the Blue and Yellow terminals and jumper the Red and Yellow terminals and the Blue and Black terminals. Adjust A4R22 for a display reading of 10.000 ±2 digits.

2. Select the 2 ohm range and short the Red and Black terminals with the Yellow terminal disconnected from the Red terminal. Adjust OFFSET for a display reading of .0000 ±1 digit.

3. Connect a 1 ohm resistor, with the four wire system, to the input. Adjust A4R7 for a display reading of 1.0000 ±1 digit.

4. Select the 200 ohm range and connect a 100 ohm resistor to the input with the four wire system. Adjust A1R10 for a display reading of 100.00 ±1 digit.

5. Select the 2K ohm range and connect a 1K ohm resistor to the input. Adjust A4R12 for a reading of 1.0000 ±1 digit.

6. Select the 20K ohm range and connect a 10K resistor to the input. Adjust A4R14 for a display reading of 10.000 ±1 digit.

7. Select the 200K ohm range and connect a 100K resistor to the input. Adjust A4R16 for a display reading of 100.00 ±1 digit.

8. Select the 200M ohm range and connect a 100M resistor to the input. Adjust A4R19 for a display reading of 100.00 ±10 digits.

9. Replace top cover without replacing retaining screws and allow unit to stand with power on for 30 minutes. Select the 20K ohm range and connect a 10K ohm resistor to the input. Remove cover and adjust A4R17 for a display reading of 10.000 ±1 digit. Replace top cover and retaining screws.

Note: The 20 ohm and 2 megohm ranges are slaved to other ranges and do not require separate adjustments. If the 20 ohm range is out of specification after calibration, touch up the 2 ohm range adjustment so both ranges are in specification.

5-27 VERIFICATION OF SPECIFICATIONS

5-28 The following procedures should be performed only after completion of the calibration procedures.

5-29 INPUT IMPEDANCE

5-30 Select the 2 volt DC range. Apply +1.0000 volts DC to the input terminals and observe the display reading. Connect a 1M ohm 1% resistor in series with the HI input lead. The display reading should not change more than 10 digits.

5-31 NORMAL MODE REJECTION

5-32 Select the 2 volt DC range. Connect the Red input terminal of the DMM-42 to the Red output terminal of the Hewlett Packard 745A and the Black and Green input terminals of the DMM-42 to the Black output terminal of the 745A. Adjust the 745A output for 3.535 volts RMS at 60 Hz. The DMM-42 display should indicate .0000 ±5 digits.

5-33 COMMON MODE REJECTION—DC

5-34 Select the 2 volt DC range. Connect the Red and Green input terminals of the DMM-42 together and to the Red output terminal of the H-P 745A. Connect the Black input terminal of the DMM-42 through a 100 ohm carbon resistor to the same point. Connect the Black output terminal of the 745A to the case of the DMM-42. Adjust the 745A output for 111.8 volts at 60 Hz and observe that the display of the DMM-42 reads .0000 ±5 digits.

5-35 COMMON MODE REJECTION—AC

5-36 Retain the connections of paragraph 5-34. Select the 1 volt AC range. Adjust the output of the H-P 745A for 3.535 volts at 60 Hz and observe that the DMM-42 display reads .0000 ±5 digits.

SECTION VI
DIAGRAMS

GENERAL

This section of the manual contains schematic and anical diagrams necessary for operation and main- ce of the Model DMM-42 Digital Multimeter. The natic diagrams illustrate the circuit while the mech- l assemblies indicate the component locations.

6-3 REFERENCE DESIGNATIONS

6-4 Partial reference designators are shown on schematic and mechanical drawings. Prefix these reference designators with assembly and/or sub-assembly designation for the complete reference designator. For example:

Assembly/Sub-Assembly	Component	Component Designation
None	T1	T1
A1	IC6	A1IC6
A2	R44	A1R44
A3	C7	A3C7
A4	Q2	A4Q2

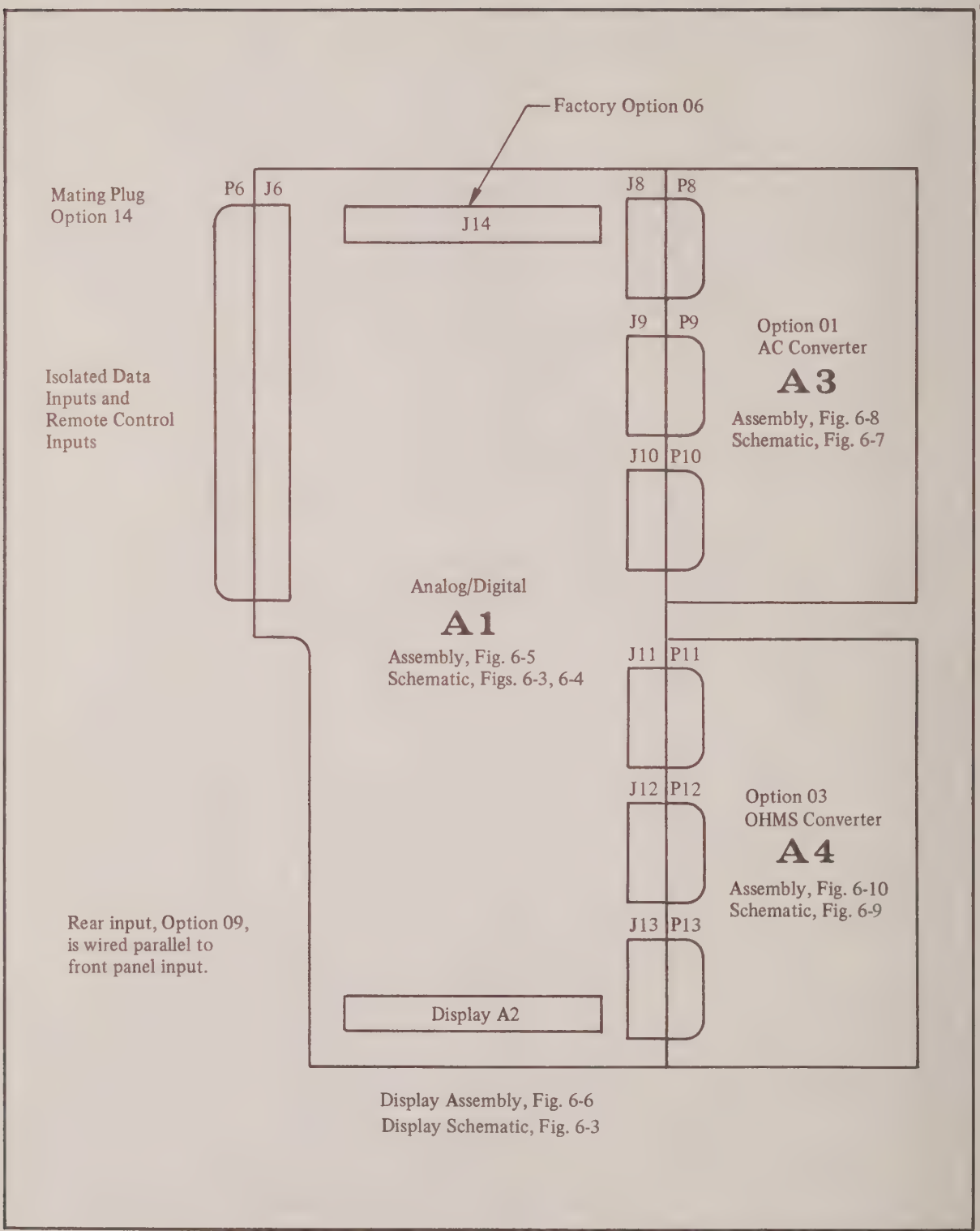
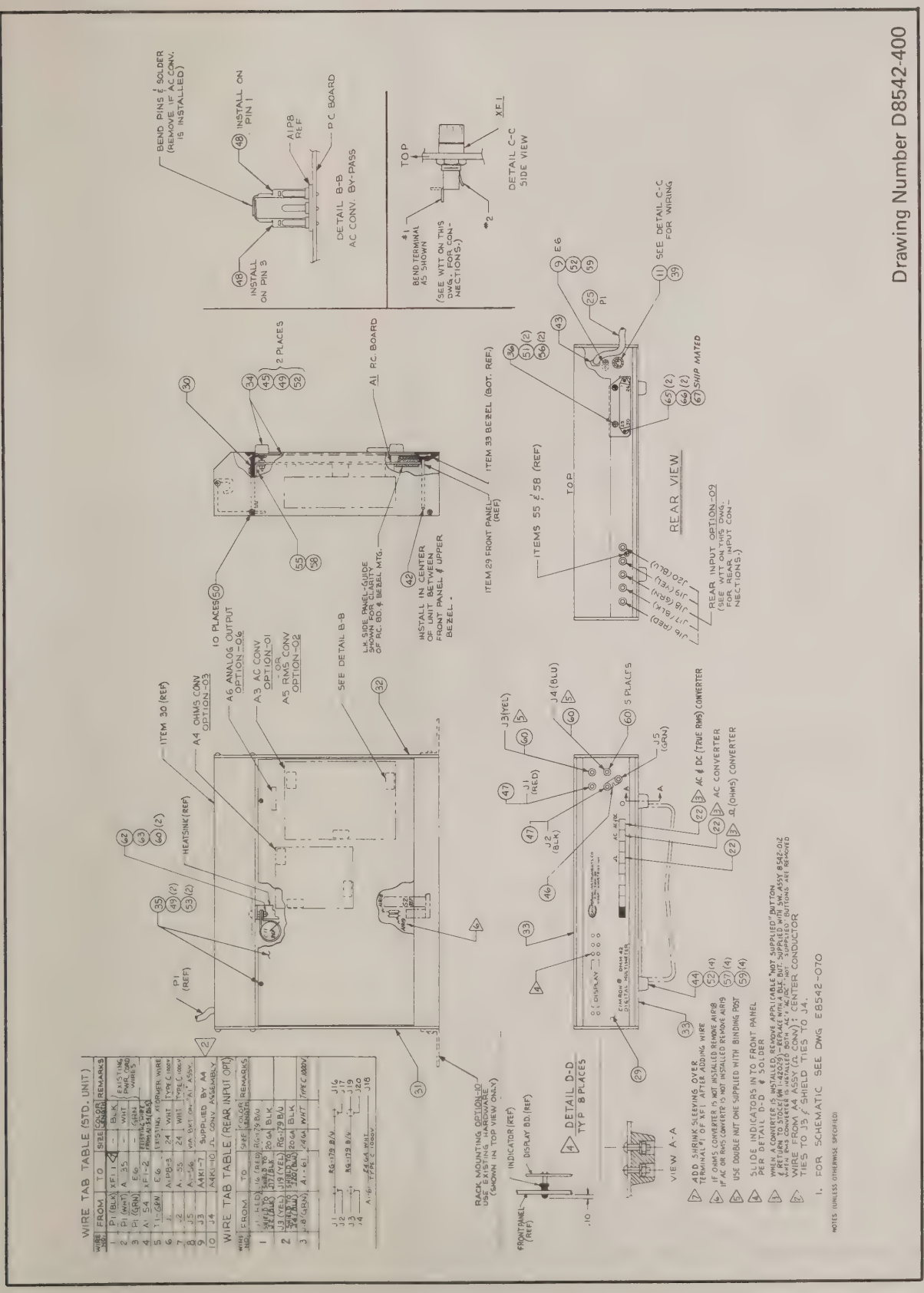


Figure 6-1. Assembly Interconnections, Model DMM-42 Digital Multimeter.



Drawing Number D8542-400

Figure 6-2. Unit Assembly, Model DMM-42 Digital Multimeter

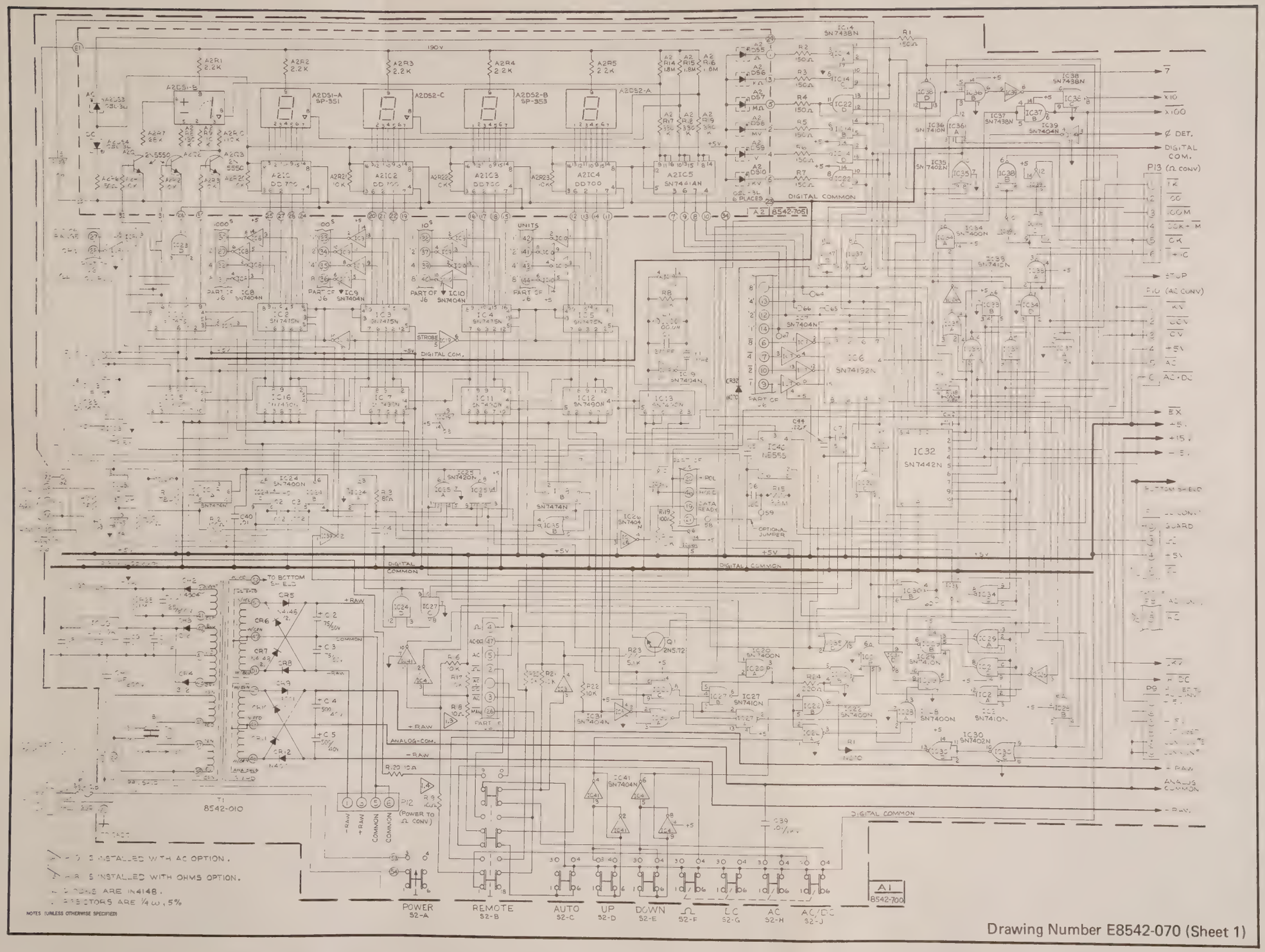
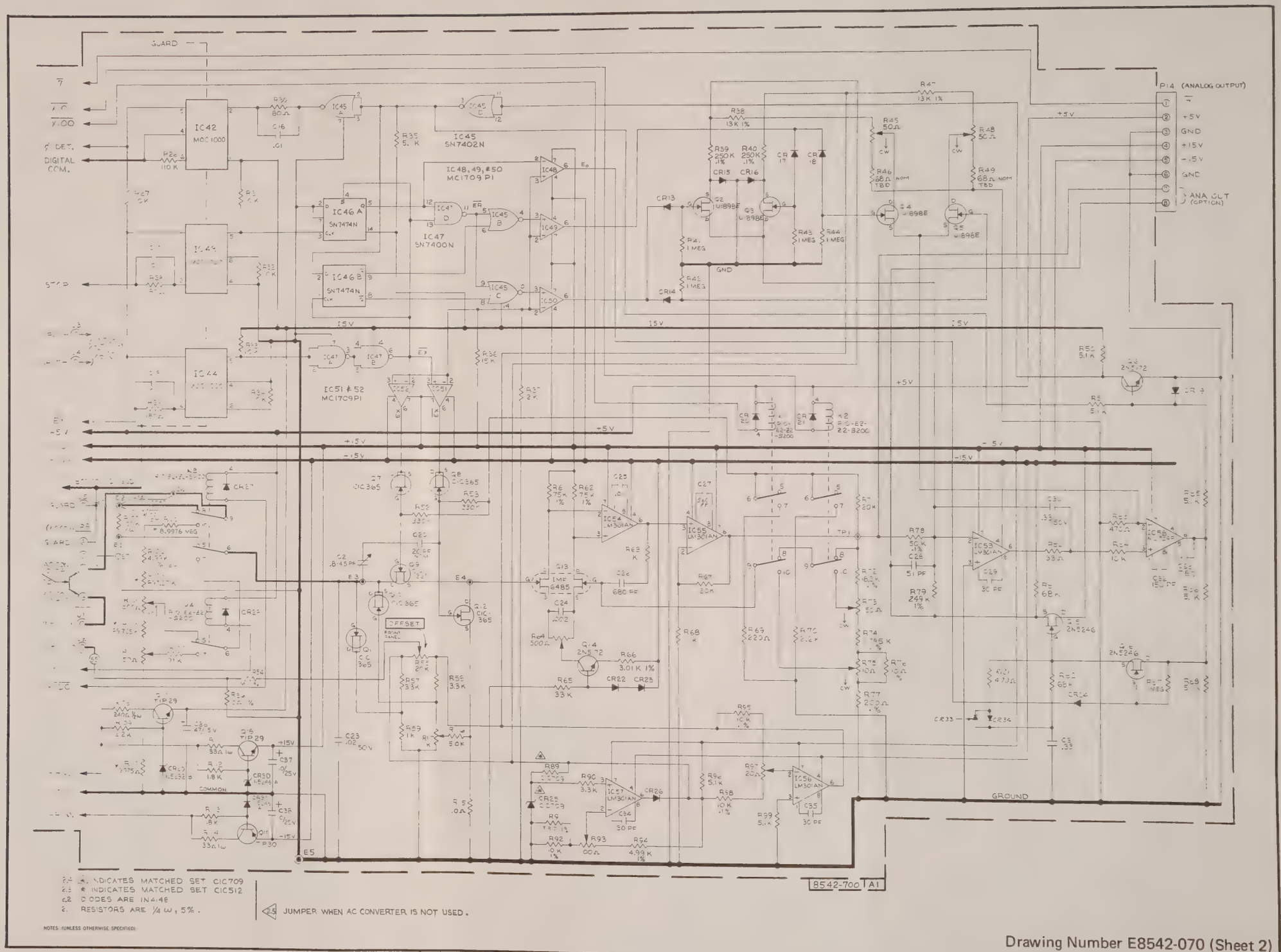


Figure 6-3. Schematic Diagram, Digital Circuits, Assembly A1 and A2



Drawing Number E8542-070 (Sheet 2)

Figure 6-4. Schematic Diagram, Analog Circuits, Assembly A1.

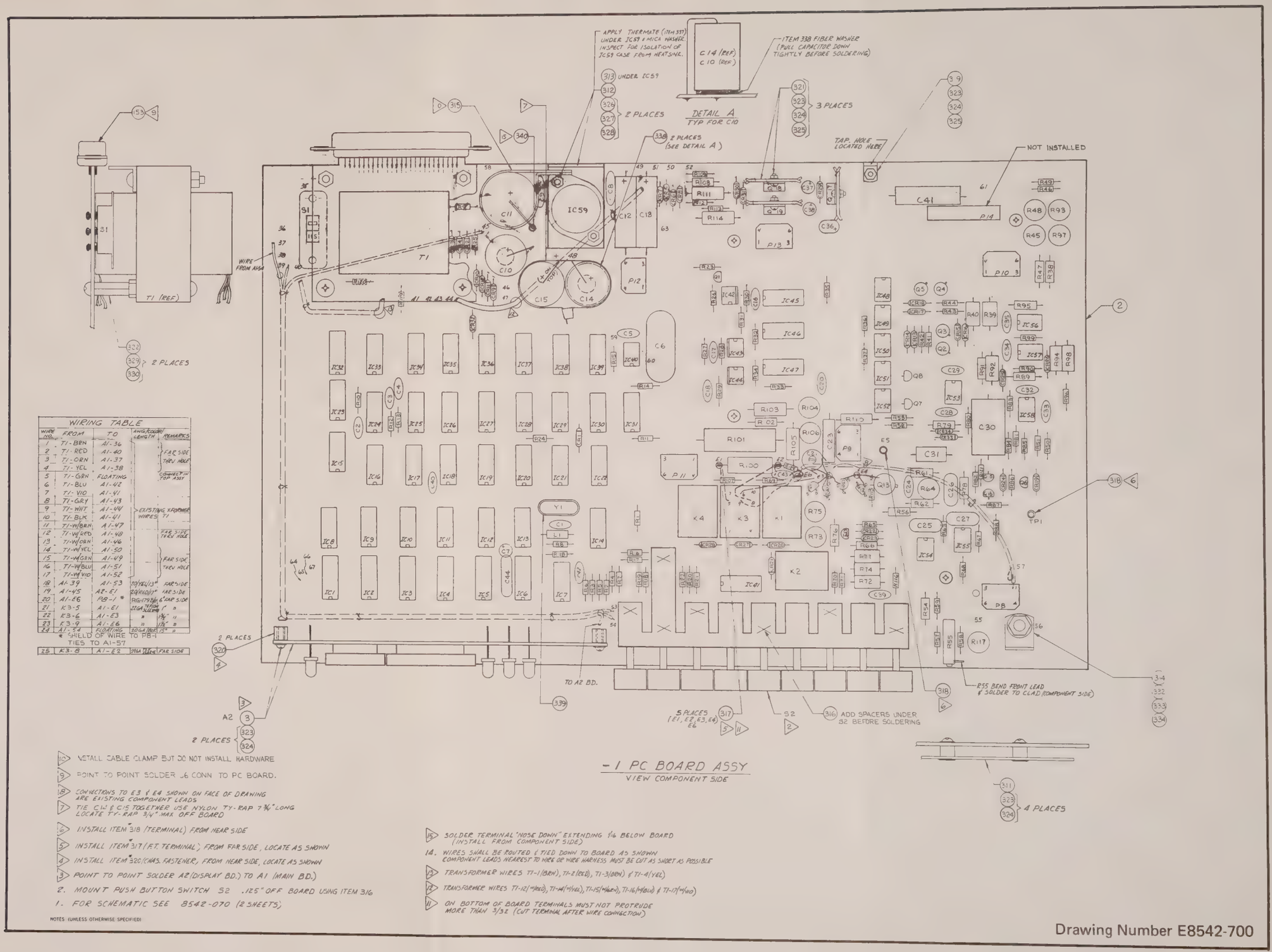
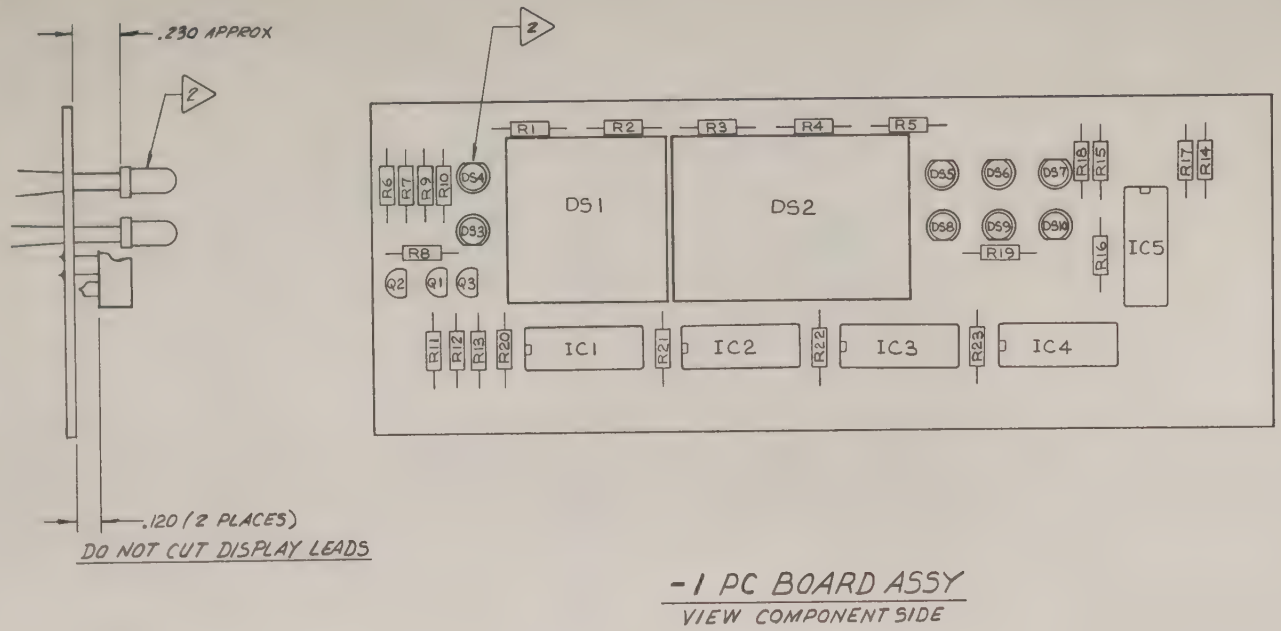

WIRING TABLE
WIRE NO. | FROM | TO | AWG/COLOR/LENGTH | REMARKS
1 | T1-BRN | A1-36
2 | T1-RED | A1-40
3 | T1-ORN | A1-37 | FAR SIDE THRU HOLE
4 | T1-YEL | A1-38
5 | T1-GRN | FLOATING | CONNECT TO TOP ASSY
6 | T1-BLU | A1-42
7 | T1-VIO | A1-41
8 | T1-GRY | A1-43
9 | T1-WHT | A1-44 | EXISTING XFORMER WIRES T1
10 | T1-BLK | A1-41
11 | T1-W/BRN | A1-47
12 | T1-W/RED | A1-48 | FAR SIDE THRU HOLE
13 | T1-W/ORN | A1-46
14 | T1-W/YEL | A1-50
15 | T1-W/GRN | A1-49 | FAR SIDE THRU HOLE
16 | T1-W/BLU | A1-51
17 | T1-W/VIO | A1-52
18 | A1-39 | A1-53 | 20/26 7/43" | FAR SIDE
19 | A1-45 | A2-E1 | RG/174/U 6" | FAR SIDE
20 | A1-E6 | P8-1 * | RG/174/U 6" | FAR SIDE
21 | K3-5 | A1-E1 | 26GA TEFLON SLEEVE | 1/8"
22 | K3-6 | A1-E3 | " | 1 3/8"
23 | K3-9 | A1-E6 | " | 1 3/8"
24 | A1-54 | FLOATING | 26GA TEFLON SLEEVE | 1 5/8"
* SHIELD OF WIRE TO P8-1 TIES TO A1-57
25 | K3-8 | A1-E2 | 24GA TEFLON SLEEVE | FAR SIDE
APPLY THERMATE (ITEM 337) UNDER IC59 & MICA WASHER. INSPECT FOR ISOLATION OF IC59 CASE FROM HEATSINK.
ITEM 338 FIBER WASHER (PULL CAPACITOR DOWN TIGHTLY BEFORE SOLDERING)
DETAIL A TYP FOR C10
C14 (REF) C10 (REF)
2 PLACES
3 PLACES
2 PLACES (SEE DETAIL A)
TAP. HOLE LOCATED HERE
NOT INSTALLED
T1 (REF)
2 PLACES
WIRE FROM A1-54
TO A2 BD.
2 PLACES
A2
2 PLACES
5 PLACES (E1, E2, E3, E4, E6)
S2
ADD SPACERS UNDER S2 BEFORE SOLDERING
R55 BEND FRONT LEAD & SOLDER TO CLAD (COMPONENT SIDE)
4 PLACES
TP1
- 1 PC BOARD ASSY
VIEW COMPONENT SIDE
(10) INSTALL CABLE CLAMP BUT DO NOT INSTALL HARDWARE
(9) POINT TO POINT SOLDER J6 CONN TO PC BOARD.
(8) CONNECTIONS TO E3 & E4 SHOWN ON FACE OF DRAWING ARE EXISTING COMPONENT LEADS
(7) TIE C1W & C1S TOGETHER USE NYLON TY-RAP 7 3/4" LONG LOCATE TY-RAP 3/4" MAX OFF BOARD
(6) INSTALL ITEM 318 (TERMINAL) FROM REAR SIDE
(5) INSTALL ITEM 317 (F.T. TERMINAL) FROM FAR SIDE, LOCATE AS SHOWN
(4) INSTALL ITEM 320 (CHAS. FASTENER) FROM REAR SIDE, LOCATE AS SHOWN
(3) POINT TO POINT SOLDER A2 (DISPLAY BD.) TO A1 (MAIN BD.)
2. MOUNT PUSH BUTTON SWITCH S2 .125" OFF BOARD USING ITEM 316
1. FOR SCHEMATIC SEE 8542-070 (2 SHEETS)
NOTES (UNLESS OTHERWISE SPECIFIED)
(15) SOLDER TERMINAL "NOSE DOWN" EXTENDING 1/16 BELOW BOARD (INSTALL FROM COMPONENT SIDE)
14. WIRES SHALL BE ROUTED & TIED DOWN TO BOARD AS SHOWN COMPONENT LEADS NEAREST TO WIRE OR WIRE HARNESS MUST BE CUT AS SHORT AS POSSIBLE
(13) TRANSFORMER WIRES T1-1 (BRN), T1-2 (RED), T1-3 (ORN) & T1-4 (YEL)
(12) TRANSFORMER WIRES T1-12 (W/RED), T1-14 (W/YEL), T1-15 (W/GRN), T1-16 (W/BLU) & T1-17 (W/VIO)
(11) ON BOTTOM OF BOARD TERMINALS MUST NOT PROTRUDE MORE THAN 3/32 (CUT TERMINAL AFTER WIRE CONNECTION)
Drawing Number E8542-700

Figure 6-5. P.C. Board Assembly A1, Digital Multimeter.



-1 PC BOARD ASSY
VIEW COMPONENT SIDE

2 INSTALL WITH FLAT IN BASE AS SHOWN IN TOP VIEW, LEAVE LEADS LONG & DO NOT SOLDER (SPREAD LEADS SLIGHTLY TO KEEP INDICATORS IN PLACE)

1. FOR SCHEMATIC SEE 8542-070

NOTES: (UNLESS OTHERWISE SPECIFIED)

Drawing Number C8542-705

Figure 6-6. P.C. Board Assembly A2, Display.

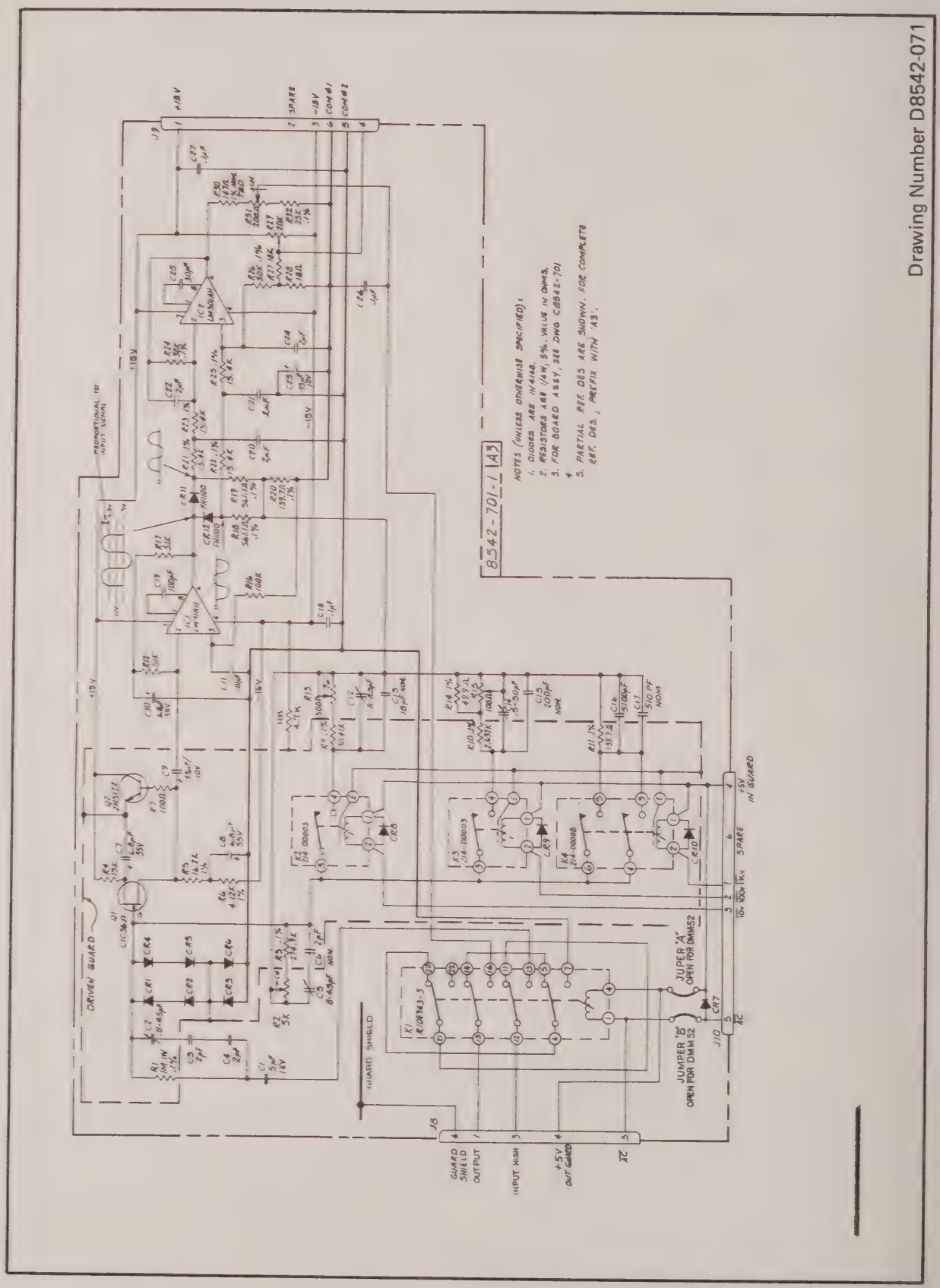


Figure 6-7. Schematic Diagram, AC Converter, Assembly A3.

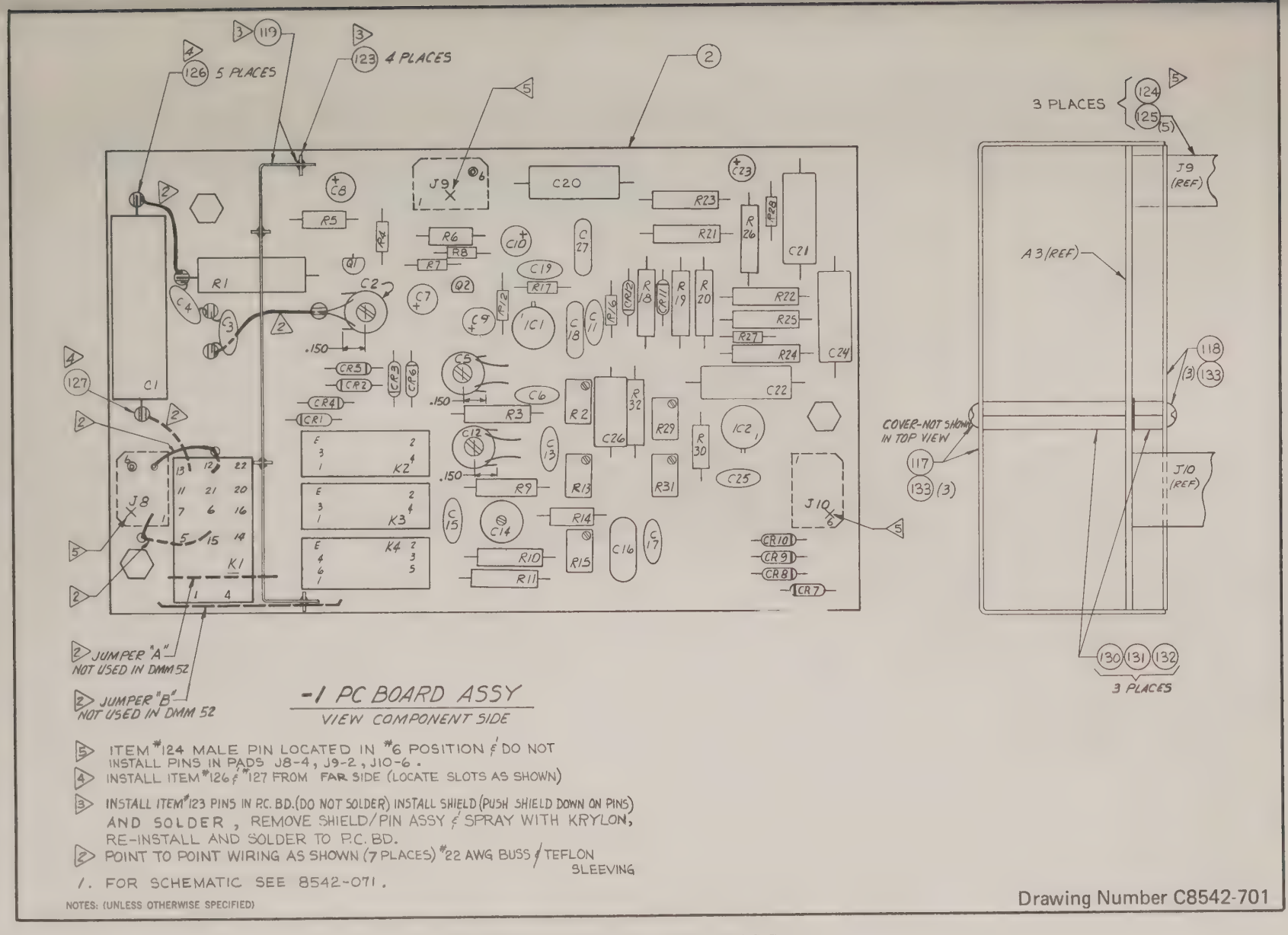
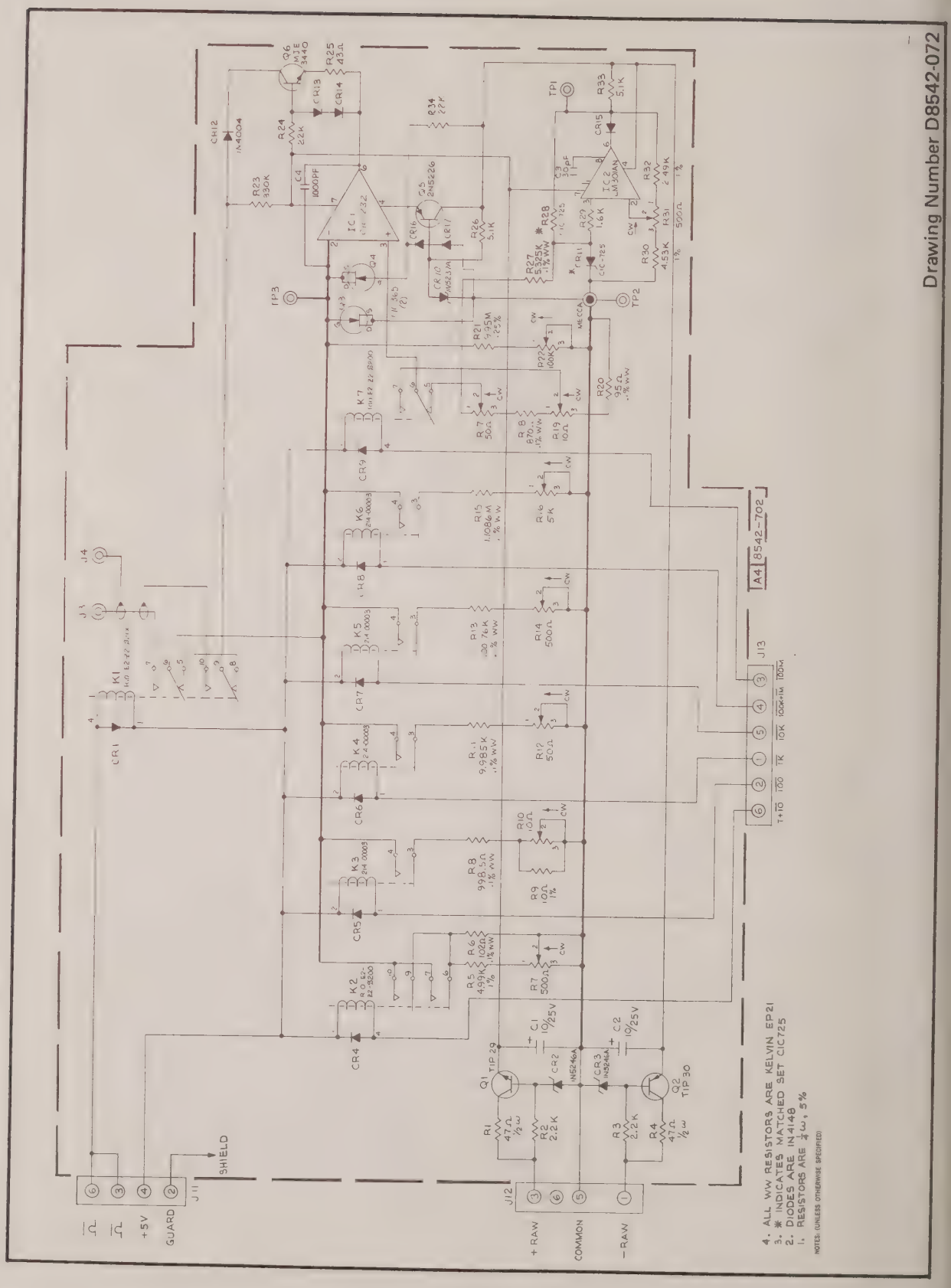
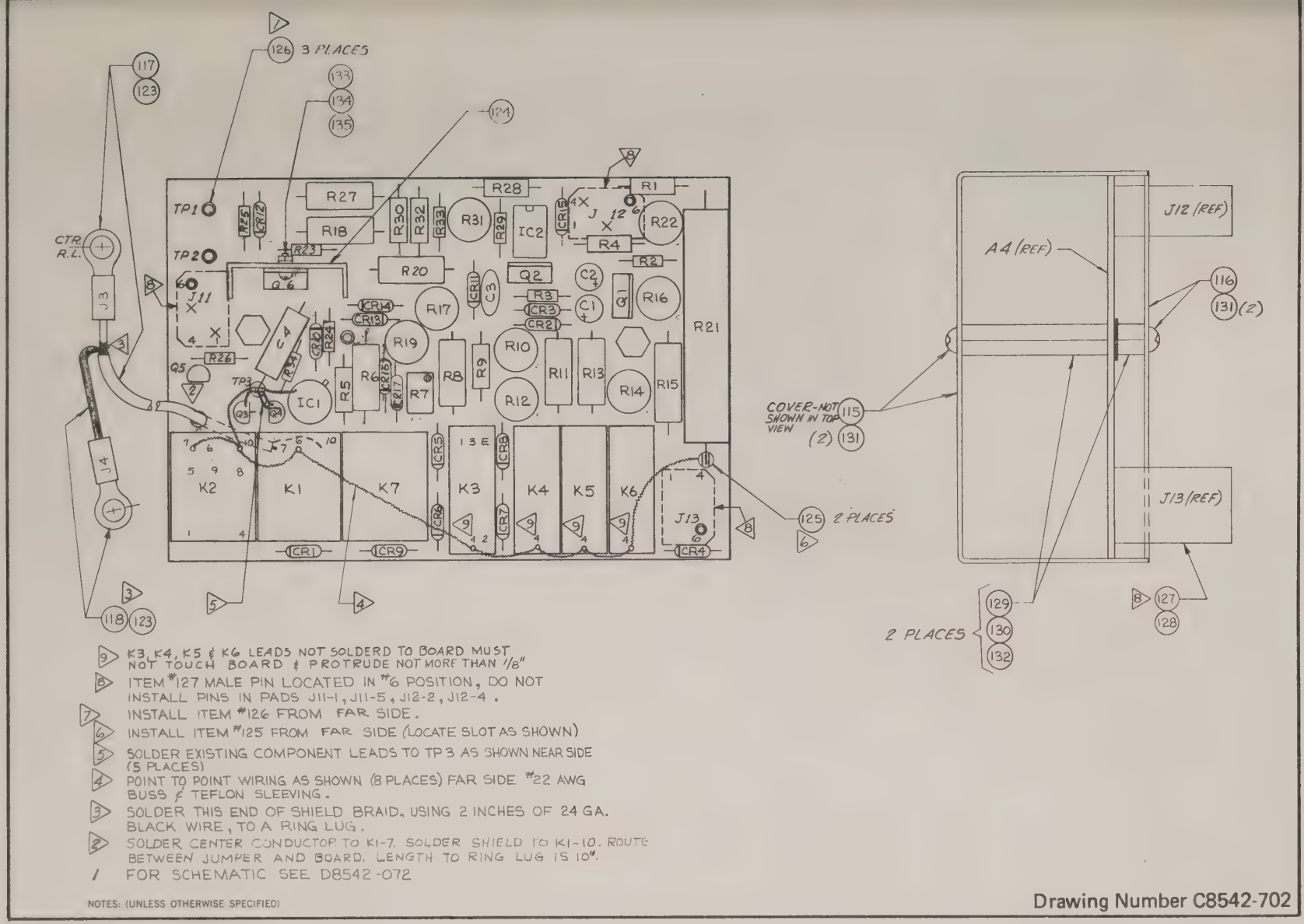


Figure 6-8. P.C. Board Assembly A3, AC Converter.



Drawing Number D8542-072



9. K3, K4, K5 & K6 LEADS NOT SOLDERD TO BOARD MUST NOT TOUCH BOARD & PROTRUDE NOT MORE THAN 1/8"
8. ITEM #127 MALE PIN LOCATED IN #6 POSITION, DO NOT INSTALL PINS IN PADS J11-1, J11-5, J12-2, J12-4.
7. INSTALL ITEM #126 FROM FAR SIDE.
6. INSTALL ITEM #125 FROM FAR SIDE (LOCATE SLOT AS SHOWN)
5. SOLDER EXISTING COMPONENT LEADS TO TP3 AS SHOWN NEAR SIDE (5 PLACES)
4. POINT TO POINT WIRING AS SHOWN (8 PLACES) FAR SIDE #22 AWG BUSS & TEFLON SLEEVING.
3. SOLDER THIS END OF SHIELD BRAID, USING 2 INCHES OF 24 GA. BLACK WIRE, TO A RING LUG.
2. SOLDER CENTER CONDUCTOR TO K1-7. SOLDER SHIELD TO K1-10. ROUTE BETWEEN JUMPER AND BOARD. LENGTH TO RING LUG IS 10".
1. FOR SCHEMATIC SEE D8542-072

NOTES: (UNLESS OTHERWISE SPECIFIED)

Drawing Number C8542-702

Figure 6-10. P.C. Board Assembly A4, OHMS Converter.

SECTION VII
REPLACEABLE PARTS LISTS

7-1 GENERAL

7-2 This section of the manual contains ordering information and complete lists of replaceable parts. Parts are listed by major assembly in alpha-numerical order of their reference designators. Description, manufacturer's code ident number and CALIFORNIA INSTRUMENTS stock numbers are indicated. A list of manufacturers and their Federal Supply Codes will be found in Appendix A.

7-3 ORDERING INFORMATION

7-4 That we may process your order promptly, please provide the following information, when applicable.

A) Model number and serial number of the instrument.

B) CALIFORNIA INSTRUMENTS part number of the sub-assembly where component is located.

C) Component reference designator.

D) Component description.

E) Component manufacturer's number and code identification.

F) CALIFORNIA INSTRUMENTS stock number.

All replacement parts orders should be placed with CALIFORNIA INSTRUMENTS COMPANY, a division of AIKEN INDUSTRIES, 5150 Convoy St., San Diego, Calif. 92111.

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
	D8542-400-1	UNIT TOP ASSEMBLY	16067		1
					2
					3
A1	8542-700-1	DIGITAL/ANALOG ASSY	16067		4
A3	8542-701-1	AC CONV. ASSY	16067		5
A4	8542-702-1	OHMS CONV. ASSY	16067		6
A5	8542-703-1	RMS CONV. ASSY	16067		7
A6	8542-704-1	ANALOG OUTPUT ASSY	16067		8
E6	1416-6	SOLDER LUG	83330	2-50047	9
					10
F1*	313.375 (115V only)	FUSE, 3/8 AMP. SLO-BLO	75915	2-40259	11
	* FOR 230V INPUT	USE P/N 323.200	75915	2-70063	12
J1	3750-RED (GOLD)	BINDING POST	05276	2-50263	13
J2	3750-BLK (GOLD)	BINDING POST	05276	2-50264	14
J3	3760-YEL	BINDING POST	05276	2-50240	15
J4	3760-BLU	BINDING POST	05276	2-50241	16
J5	3760-GRN	BINDING POST	05276	2-50202	17
					18
					19
					20
					21
	8300-230	BUTTON (NOT SUPPLIED)	16067	1-42029	22
					23
					24
P1	17237	POWER CORD	70903	2-50203	25
					26
					27
					28
	C8542-200-7	FRONT PANEL	16067	2-10494	29
	D8542-201-7	REAR PANEL	16067	1-10424	30
	C8545-205-8	SIDE PANEL (LEFT)	16067	1-10413	31
	C8545-205-7	SIDE PANEL (RIGHT)	16067	1-10400	32
	B8545-206-7	BEZEL, TOP-BOTTOM	16067	1-10401	33
	D8545-207-8	COVER, BOTTOM	16067	1-10403	34
	D8545-207-10	COVER, TOP	16067	1-10501	35
	B8542-213-7	PLATE, CONNECTOR MTG.	16067	1-10545	36

MODEL DMM 42 | CALICO P/N 8542-400 | ASSY R.D.

TITLE UNIT ASSEMBLY | SHT 3 OF 4

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
					37
					38
XF1	345001	FUSE HOLDER	75915	2-40264	39
					40
					41
	1/8 DIA. x 6" LG	SHRINK TUBING			42
	SR-5L-1	STRAIN RELIEF	28520	2-10480	43
	10" BAIL SET	BAIL	21604	2-10351	44
	2090	RUBBER FEET	08065	2-10547	45
	327	SHORTING STRAP	83330	2-50159	46
	1416-8	SOLDER LUG	83330	2-50053	47
	02-09-1132	PIN, FEMALE	27264	4-10205	48
	C8091-632	NUT CLIP	78553	2-10484	49
	8-32 x 3/4" LG	TYPE F THD CUTTING SCR, P.H	45722	2-10481	50
	8-32 x 3/8" LG	SCREW, PAN HEAD			51
	6-32 x 7/16" LG	SCREW, PAN HEAD			52
	6-32 x 1/4" LG	SCREW, PAN HEAD			53
					54
	4-40 x 5/16" LG	SCREW, PAN HEAD			55
	#8	WASHER, INT. STAR			56
	#6	WASHER, INT. STAR			57
	#4	WASHER, INT. STAR			58
	6-32 1/4 HEX	NUT			59
	8-32 1/4 HEX	NUT			60
					61
	8-32 x 5/8	SCREW, PAN HEAD			62
	#8	WASHER FLAT			63
					64
	3-48 x 3/16LG	SCREW, PAN HD		2-10583	65
	#3	WASHER, INT. STAR		2-10584	66
	57-30500	CONNECTOR, PLUG	02660	4-10022	67
					68
					69
					70
					71
					72

MODEL DMM 42 | CALICO P/N 8542-400 | ASSY R.D.

TITLE UNIT ASSEMBLY | SHT 4 OF 4

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1	8542-700-1	P.C. BOARD, ASSY	16067		1
	8542-700-7	P.C. BOARD, MECH	16067	1-60204	2
A2	8542-705-1	P.C. BOARD, ASSY	16067		3
					4
					5
					6
A1C1	CM05F271J03	CAPACITOR 270pF 500V	81349	6-10040	7
A1C2	5GA-D20	CAPACITOR .002μF 1KV	56289	6-10055	8
A1C3	5GA-D20	CAPACITOR .002μF 1KV	56289	6-10055	9
A1C4	TG-P10	CAPACITOR .1μF 100V	56289	6-10127	10
A1C5	CK-103	CAPACITOR .01μF 50V	71590	6-10094	11
A1C6	1DP-3-224	CAPACITOR .22μF 100V	72136	6-10566	12
A1C7	T362B156M020AS	CAPACITOR 15μF 20V	05397	6-10813	13
A1C8	TG-P10	CAPACITOR .1μF 100V	56289	6-10127	14
A1C9	TG-P10	CAPACITOR .1μF 100V	56289	6-10127	15
A1C10	C436AR/N25	CAPACITOR 25μF 300V	80031	6-10934	16
A1C11	39D408G015GL4	CAPACITOR 4000μF 15V	56289	6-10631	17
A1C12	TE-1308	CAPACITOR 75μF 50V	56289	6-10998	18
A1C13	TE-1308	CAPACITOR 75μF 50V	56289	6-10998	19
A1C14	066GJ501U040B	CAPACITOR 500μF 40V	00853	6-10912	20
A1C15	066GJ501U040B	CAPACITOR 500μF 40V	00853	6-10912	21
A1C16	CK-103	CAPACITOR .01μF 50V	71590	6-10094	22
A1C17	CK-103	CAPACITOR .01μF 50V	71590	6-10094	23
A1C18	CK-103	CAPACITOR .01μF 50V	71590	6-10094	24
A1C19	NOT USED	CAPACITOR			25
A1C20	CM05ED200J03	CAPACITOR 20pF 500V	81349	6-10008	26
A1C21	561-013	CAPACITOR VAR. .8-4.5pF	72982	6-10909	27
A1C22	NOT USED	CAPACITOR			28
A1C23	PA2A203K	CAPACITOR .02μF 50V	27556	6-10914	29
A1C24	5GA-D20	CAPACITOR .002μF 1KV	56289	6-10055	30
A1C25	CK-103	CAPACITOR .01μF 50V	71590	6-10094	31
A1C26	CM06FD681F03	CAPACITOR 680pF 500V	81349	6-10047	32
A1C27	CM06F561J03	CAPACITOR 560pf 500V	81349	6-10293	33
A1C28	CM05ED510J03	CAPACITOR 51pF 500V	81349	6-10016	34
A1C29	CM05ED300J03	CAPACITOR 30pF 500V	81349	6-10263	35
A1C30	PD5A-334K	CAPACITOR .33μF 50V	12406	6-10911	36

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PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1C31	BA2A334	CAPACITOR .33μF 50V	27556	6-10983	37
A1C32	CM05F151F03	CAPACITOR 150pF 500V	81349	6-10467	38
A1C33		CAPACITOR T.B.D.			39
A1C34	CM05ED300J03	CAPACITOR 30pF 500V	81349	6-10263	40
A1C35	CM05ED300J03	CAPACITOR 30pF 500V	81349	6-10263	41
A1C36	T362C476M015AS	CAPACITOR 47μF 15V	05397	6-10877	42
A1C37	T362B106M025AS	CAPACITOR 10μF 25V	05397	6-10738	43
A1C38	T362B106M025AS	CAPACITOR 10μF 25V	05397	6-10738	44
A1C39	5GA-S10	CAPACITOR .01μF 1KV	56289	6-10086	45
A1C40	CK-103	CAPACITOR .01μF 50V	71590	6-10094	46
A1C41	ZD2A105K	CAPACITOR 1μF 200V	12406	6-10591	47
A1C42	TG-P10	CAPACITOR .1μF 100V	56289	6-10127	48
A1C43	5GA-D47	CAPACITOR .0047μF 1KV	56289	6-10075	49
A1C44	C280AE/A220K	CAPACITOR .22μF 250V	73445	6-10881	50
					51
					52
A1CR1	1N270	DIODE	81349	3-10006	53
A1CR2	1N4004	DIODE	04713	3-10062	54
A1CR3	S12	DIODE	14099	3-10079	55
A1CR4	S12	DIODE	14099	3-10079	56
A1CR5	1N4148	DIODE	25403	3-10227	57
A1CR6	1N4148	DIODE	25403	3-10227	58
A1CR7	1N4148	DIODE	25403	3-10227	59
A1CR8	1N4148	DIODE	25403	3-10227	60
A1CR9	1N4001	DIODE	04713	3-10172	61
A1CR10	1N4001	DIODE	04713	3-10172	62
A1CR11	1N4001	DIODE	04713	3-10172	63
A1CR12	1N4001	DIODE	04713	3-10172	64
A1CR13	1N4148	DIODE	25403	3-10227	65
A1CR14	1N4148	DIODE	25403	3-10227	66
A1CR15	1N4148	DIODE	25403	3-10227	67
A1CR16	1N4148	DIODE	25403	3-10227	68
A1CR17	1N4148	DIODE	25403	3-10227	69
A1CR18	1N4148	DIODE	25403	3-10227	70
A1CR19	1N4148	DIODE	25403	3-10227	71
A1CR20	1N4148	DIODE	25403	3-10227	72

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PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1CR21	1N4148	DIODE	25403	3-10227	73
A1CR22	1N4148	DIODE	25403	3-10227	74
A1CR23	1N4148	DIODE	25403	3-10227	75
A1CR24	1N4148	DIODE	25403	3-10227	76
A1CR25	CIC 709	DIODE, REFERENCE SET	16067	3-10225	77
A1CR26	1N4148	DIODE	25403	3-10227	78
A1CR27	1N4148	DIODE	25403	3-10227	79
A1CR28	1N4148	DIODE	25403	3-10227	80
A1CR29	1N5232B	DIODE, ZENER	04713	3-10125	81
A1CR30	1N5246A	DIODE, ZENER	04713	3-10145	82
A1CR31	1N5246A	DIODE, ZENER	04713	3-10145	83
A1CR32	1N270	DIODE	81349	3-10006	84
A1CR33	1N4148	DIODE	25403	3-10227	85
A1CR34	1N4148	DIODE	25403	3-10227	86
					87
					88
A1IC1	SN7475N	INTEGRATED CIRCUIT	27014	3-60004	89
A1IC2	SN7475N	INTEGRATED CIRCUIT	27014	3-60004	90
A1IC3	SN7475N	INTEGRATED CIRCUIT	27014	3-60004	91
A1IC4	SN7475N	INTEGRATED CIRCUIT	27014	3-60004	92
A1IC5	SN7475N	INTEGRATED CIRCUIT	27014	3-60004	93
A1IC6	SN74192N	INTEGRATED CIRCUIT	27014	3-60014	94
A1IC7	SN7404N	INTEGRATED CIRCUIT	27014	3-60002	95
A1IC8	SN7404N	INTEGRATED CIRCUIT	27014	3-60002	96
A1IC9	SN7404N	INTEGRATED CIRCUIT	27014	3-60002	97
A1IC10	SN7404N	INTEGRATED CIRCUIT	27014	3-60002	98
A1IC11	SN7490N	INTEGRATED CIRCUIT	27014	3-60005	99
A1IC12	SN7490N	INTEGRATED CIRCUIT	27014	3-60005	100
A1IC13	SN7490N	INTEGRATED CIRCUIT	27014	3-60005	101
A1IC14	SN7438N	INTEGRATED CIRCUIT	27014	3-60050	102
A1IC15	SN7490N	INTEGRATED CIRCUIT	27014	3-60005	103
A1IC16	SN7490N	INTEGRATED CIRCUIT	27014	3-60005	104
A1IC17	SN7490N	INTEGRATED CIRCUIT	27014	3-60005	105
A1IC18	SN7474N	INTEGRATED CIRCUIT	27014	3-60025	106
A1IC19	SN7404N	INTEGRATED CIRCUIT	27014	3-60002	107
A1IC20	SN7400N	INTEGRATED CIRCUIT	27014	3-60000	109

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PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1IC21	SN7410N	INTEGRATED CIRCUIT	27014	3-60051	109
A1IC22	SN7400N	INTEGRATED CIRCUIT	27014	3-60000	110
A1IC23	SN7400N	INTEGRATED CIRCUIT	27014	3-60000	111
A1IC24	SN7400N	INTEGRATED CIRCUIT	27014	3-60000	112
A1IC25	SN7420N	INTEGRATED CIRCUIT	27014	3-60012	113
A1IC26	SN7404N	INTEGRATED CIRCUIT	27014	3-60002	114
A1IC27	SN7410N	INTEGRATED CIRCUIT	27014	3-60051	115
A1IC28	SN7400N	INTEGRATED CIRCUIT	27014	3-60000	116
A1IC29	SN7410N	INTEGRATED CIRCUIT	27014	3-60051	117
A1IC30	SN7402N	INTEGRATED CIRCUIT	27014	3-60001	118
A1IC31	SN7404N	INTEGRATED CIRCUIT	27014	3-60002	119
A1IC32	SN7442N	INTEGRATED CIRCUIT	27014	3-60013	120
A1IC33	SN7410N	INTEGRATED CIRCUIT	27014	3-60051	121
A1IC34	SN7400N	INTEGRATED CIRCUIT	27014	3-60000	122
A1IC35	SN7402N	INTEGRATED CIRCUIT	27014	3-60001	123
A1IC36	SN7410N	INTEGRATED CIRCUIT	27014	3-60051	124
A1IC37	SN7438N	INTEGRATED CIRCUIT	27014	3-60050	125
A1IC38	SN7438N	INTEGRATED CIRCUIT	27014	3-60050	126
A1IC39	SN7404N	INTEGRATED CIRCUIT	27014	3-60002	127
A1IC40	NE555V	INTEGRATED CIRCUIT	18324	3-60026	128
A1IC41	SN7404N	INTEGRATED CIRCUIT	27014	3-60002	129
A1IC42	MOC 1000	PHOTO MODULATOR	04713	2-50211	130
A1IC43	MOC 1000	PHOTO MODULATOR	04713	2-50211	131
A1IC44	MOC 1000	PHOTO MODULATOR	04713	2-50211	132
A1IC45	SN7402N	INTEGRATED CIRCUIT	27014	3-60001	133
A1IC46	SN7474N	INTEGRATED CIRCUIT	27014	3-60025	134
A1IC47	SN7400N	INTEGRATED CIRCUIT	27014	3-60000	135
A1IC48	MC1709P1	INTEGRATED CIRCUIT	27014	3-60041	136
A1IC49	MC1709P1	INTEGRATED CIRCUIT	27014	3-60041	137
A1IC50	MC1709P1	INTEGRATED CIRCUIT	27014	3-60041	138
A1IC51	MC1709P1	INTEGRATED CIRCUIT	27014	3-60041	139
A1IC52	MC1709P1	INTEGRATED CIRCUIT	27014	3-60041	140
A1IC53	LM301AN	INTEGRATED CIRCUIT	27014	3-60029	141
A1IC54	LM301AN	INTEGRATED CIRCUIT	27014	3-60029	142
A1IC55	LM301AN	INTEGRATED CIRCUIT	27014	3-60029	143
A1IC56	LM301AN	INTEGRATED CIRCUIT	27014	3-60029	144

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REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO
A1IC57	LM301AN	INTEGRATED CIRCUIT	27014	3-[illegible]0029	145
A1IC58	MC1709P1	INTEGRATED CIRCUIT	27014	3-[illegible]0041	146
A1IC59	LM309K	INTEGRATED CIRCUIT	27014	3-[illegible]0007	147
					148
					149
					150
					151
					152
A1J6	57-40500	CONNECTOR	02660	4-10024	153
					154
					155
					156
A1K1	R10-E2-Z2-S200	RELAY	24796	2-45129	157
A1K2	R10-E2-Z2-S200	RELAY	24796	2-45129	158
A1K3	R10-E2-Z2-S200	RELAY	24796	2-45129	159
A1K4	R10-E2-Z2-S200	RELAY	24796	2-45129	160
					161
					162
					163
A1L1	DD100	CHOKE 100μH	83125	5-90057	164
					165
					166
					167
A1P8	09-18-5061	CONNECTOR	27264	4-10206	168
A1P9	09-18-5061	CONNECTOR	27264	4-10206	169
A1P10	09-18-5061	CONNECTOR	27264	4-10206	170
A1P11	09-18-5061	CONNECTOR	27264	4-10206	171
A1P12	09-18-5061	CONNECTOR	27264	4-10206	172
A1P13	09-18-5061	CONNECTOR	27264	4-10206	173
A1P14	NOT USED (ALLOCATED FOR ANALOG OUTPUT OPTION)				174
					175
					176
					177
					178
					179
					180

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PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1Q1	2N5172	TRANSISTOR	56289	3-30219	145
A1Q2	U1898E	TRANSISTOR F.E.T.	15818	3-30217	146
A1Q3	U1898E	TRANSISTOR F.E.T.	15818	3-30217	147
A1Q4	U1898E	TRANSISTOR F.E.T.	15818	3-30217	148
A1Q5	U1898E	TRANSISTOR F.E.T.	15818	3-30217	149
A1Q6	2N5172	TRANSISTOR	56289	3-30219	150
A1Q7	CIC 365	TRANSISTOR F.E.T.	16067	3-30245	151
A1Q8	CIC 365	TRANSISTOR F.E.T.	16067	3-30245	152
A1Q9	CIC 365	TRANSISTOR F.E.T.	16067	3-30245	153
A1Q10	CIC 365	TRANSISTOR F.E.T.	16067	3-30245	154
A1Q11	CIC 365	TRANSISTOR F.E.T.	16067	3-30245	155
A1Q12	CIC 365	TRANSISTOR F.E.T.	16067	3-30245	156
A1Q13	IMF 6485	TRANSISTOR, DUAL F.E.T.	0000L	3-30256	157
A1Q14	2N5172	TRANSISTOR	56289	3-30219	158
A1Q15	2N5246	TRANSISTOR F.E.T.	0000L	3-30243	159
A1Q16	2N5246	TRANSISTOR F.E.T.	0000L	3-30243	160
A1Q17	T1P29	TRANSISTOR	01295	3-30241	161
A1Q18	T1P29	TRANSISTOR	01295	3-30241	162
A1Q19	T1P30	TRANSISTOR	01295	3-30250	163
					164
					165
					166
					167
					168
A1R1	RC07GF151J	RESISTOR 150Ω 5% 1/4W	81349	5-10033	169
A1R2	RC07GF151J	RESISTOR 150Ω 5% 1/4W	81349	5-10033	170
A1R3	RC07GF151J	RESISTOR 150Ω 5% 1/4W	81349	5-10033	171
A1R4	RC07GF151J	RESISTOR 150Ω 5% 1/4W	81349	5-10033	172
A1R5	RC07GF151J	RESISTOR 150Ω 5% 1/4W	81349	5-10033	173
A1R6	RC07GF151J	RESISTOR 150Ω 5% 1/4W	81349	5-10033	174
A1R7	RC07GF151J	RESISTOR 150Ω 5% 1/4W	81349	5-10033	175
A1R8	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-10076	176
A1R9	RC07GF100J	RESISTOR 10Ω 5% 1/4W	81349	5-10005	177
A1R10	RC07GF101J	RESISTOR 100Ω 5% 1/4W	81349	5-10029	178
A1R11		RESISTOR TBD			179
A1R12	RC07GF101J	RESISTOR 100Ω 5% 1/4W	81349	5-10029	180

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REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1R13	RC07GF181J	RESISTOR 180Ω 5% 1/4W	81349	5-10035	181
A1R14	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-1007c	182
A1R15	RC07GF335J	RESISTOR 3.3M 5% 1/4W	81349	5-10129	183
A1R16	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-1007c	184
A1R17	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-1007c	185
A1R18	RC07GF100J	RESISTOR 10Ω 5% 1/4W	81349	5-10005	186
A1R19	RC07GF100J	RESISTOR 10Ω 5% 1/4W	81349	5-10005	187
A1R20	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-1007c	188
A1R21	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-1007c	189
A1R22	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-1007c	190
A1R23	RC07GF512J	RESISTOR 5.1K 5% 1/4W	81349	5-100c9	191
A1R24	RC07GF221J	RESISTOR 220Ω 5% 1/4W	81349	5-10037	192
A1R25	RC07GF105J	RESISTOR 1M 5% 1/4W	81349	5-10123	193
A1R26	RC07GF114J	RESISTOR 110K 5% 1/4W	81349	5-10101	194
A1R27	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-1007c	195
A1R28	RC07GF181J	RESISTOR 180Ω 5% 1/4W	81349	5-10035	196
A1R29	RC07GF181J	RESISTOR 180Ω 5% 1/4W	81349	5-10035	197
A1R30	RC07GF181J	RESISTOR 180Ω 5% 1/4W	81349	5-10035	198
A1R31	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-1007c	199
A1R32	RC07GF114J	RESISTOR 110K 5% 1/4W	81349	5-10101	200
A1R33	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-1007c	201
A1R34	RC07GF114J	RESISTOR 110K 5% 1/4W	81349	5-10101	202
A1R35	RC07GF512J	RESISTOR 5.1K 5% 1/4W	81349	5-100c9	203
A1R36	RC07GF153J	RESISTOR 15K 5% 1/4W	81349	5-10080	204
A1R37	RC07GF202J	RESISTOR 2K 5% 1/4W	81349	5-10059	205
A1R38	RNc0D1302F	RESISTOR 13K 1% 1/4W	81349	5-c0090	206
A1R39	EP21-250K .1%	RESISTOR 250K .1% 15PPM	07088	5-80367	207
A1R40	EP21-250K .1%	RESISTOR 250K .1% 15PPM	07088	5-80367	208
A1R41	RC07GF105J	RESISTOR 1M 5% 1/4W	81349	5-10123	209
A1R42	RC07GF105J	RESISTOR 1M 5% 1/4W	81349	5-10123	210
A1R43	RC07GF105J	RESISTOR 1M 5% 1/4W	81349	5-10123	211
A1R44	RC07GF105J	RESISTOR 1M 5% 1/4W	81349	5-10123	212
A1R45	91A-50Ω	POTENTIOMETER 50Ω	73138	5-70201	213
A1R46	RC07GFc80J	RESISTOR c8Ω 5% 1/4W	81349	5-10025	214
A1R47	RNc0D1302F	RESISTOR 13K 1% 1/4W	81349	5-c0090	215
A1R48	91A-50Ω	POTENTIOMETER 50Ω	73138	5-70201	216

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PARTS LIST

REF DES	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1R49	RC07GF680J	RESISTOR 68Ω 5% 1/4W	81349	5-10025	217
A1R50	RC07GF512J	RESISTOR 5.1K 5% 1/4W	81349	5-10069	218
A1R51	RC07GF512J	RESISTOR 5.1K 5% 1/4W	81349	5-10069	219
A1R52	RC07GF334J	RESISTOR 330K 5% 1/4W	81349	5-10112	220
A1R53	RC07GF334J	RESISTOR 330K 5% 1/4W	81349	5-10112	221
A1R54	RN60D1004J	RESISTOR 1M 1% 1/4W	81349	5-60176	222
A1R55	ET34X203	POTENTIOMETER 20K	30983	5-70223	223
A1R56	RN60D10R0F	RESISTOR 10Ω 1% 1/4W	81349	5-60455	224
A1R57	RC07GF332J	RESISTOR 3.3K 5% 1/4W	81349	5-10064	225
A1R58	RC07GF332J	RESISTOR 3.3K 5% 1/4W	81349	5-10064	226
A1R59	RC07GF102J	RESISTOR 1K 5% 1/4W	81349	5-10053	227
A1R60	NOT USED	RESISTOR			228
A1R61	RN60D7502F	RESISTOR 75K 1% 1/4W	81349	5-60215	229
A1R62	RN60D7502F	RESISTOR 75K 1% 1/4W	81349	5-60215	230
A1R63	RC07GF102J	RESISTOR 1K 5% 1/4W	81349	5-10053	231
A1R64	91A-500Ω	POTENTIOMETER 500Ω	73138	5-70220	232
A1R65	RC07GF333J	RESISTOR 33K 5% 1/4W	81349	5-10088	233
A1R66	RN60D3011F	RESISTOR 3.01K 1% 1/4W	81349	5-60041	234
A1R67	RC07GF203J	RESISTOR 20K 5% 1/4W	81349	5-10083	235
A1R68	RC07GF102J	RESISTOR 1K 5% 1/4W	81349	5-10053	236
A1R69	RC07GF221J	RESISTOR 220Ω 5% 1/4W	81349	5-10037	237
A1R70	RC07GF222J	RESISTOR 2.2K 5% 1/4W	81349	5-10060	238
A1R71	RC07GF203J	RESISTOR 20K 5% 1/4W	81349	5-10083	239
A1R72	EP21-18.2K .1%	RESISTOR 18.2K .1% 15PPM	07088	5-80368	240
A1R73	91A-50Ω	POTENTIOMETER 50Ω	73138	5-70201	241
A1R74	EP21-1.795K .1%	RESISTOR 1.795K .1% 15PPM	07088	5-80369	242
A1R75	91A-10Ω	POTENTIOMETER 10Ω	73138	5-70202	243
A1R76	RN60D10R0F	RESISTOR 10Ω 1% 1/4W	81349	5-60455	244
A1R77	EP21-200Ω .1%	RESISTOR 200Ω .1% 15PPM	07088	5-80370	245
A1R78	EP21-50K .1%	RESISTOR 50K .1% 15PPM	07088	5-80371	246
A1R79	RN60D2493F	RESISTOR 249K 1% 1/4W	81349	5-60151	247
A1R80	RC07GF330J	RESISTOR 33Ω 5% 1/4W	81349	5-10017	248
A1R81	RC07GF683J	RESISTOR 68K 5% 1/4W	81349	5-10096	249
A1R82	RC07GF683J	RESISTOR 68K 5% 1/4W	81349	5-10096	250
A1R83	RC07GF471J	RESISTOR 470Ω 5% 1/4W	81349	5-10045	251
A1R84	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-10070	252

MODEL	CALICO P/N	ASSY R.D.
DMM 42	8542-700	
TITLE P.C. BOARD ASSEMBLY - DIGITAL/ANALOG	SHT 11 OF 14	A1

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1R85	RC07GF512J	RESISTOR 5.1K 5% 1/4W	81349	5-10069	253
A1R86	RC07GF512J	RESISTOR 5.1K 5% 1/4W	81349	5-10069	254
A1R87	RC07GF105J	RESISTOR 1M 5% 1/4W	81349	5-10123	255
A1R88	RC07GF512J	RESISTOR 5.1K 5% 1/4W	81349	5-10069	256
A1R89	CIC 709	RESISTOR, REFERENCE SET	16067	3-10225	257
A1R90	RC07GF332J	RESISTOR 3.3K 5% 1/4W	81349	5-10064	258
A1R91		RESISTOR T.B.D. 1%			259
A1R92	EP21-10K- 1%	RESISTOR 10K 1% 15PPM	07088	5-80372	260
A1R93	91A-100Ω	POTENTIOMETER 100Ω	73138	5-70205	261
A1R94	EP21-4.99K-1%	RESISTOR 4.99K 1% 15PPM	07088	5-80373	262
A1R95	EP21-10K .1%	RESISTOR 10K .1% 15PPM	07088	5-80374	263
A1R96	RC07GF512J	RESISTOR 5.1K 5% 1/4W	81349	5-10069	264
A1R97	91A-20Ω	POTENTIOMETER 20Ω	73138	5-70206	265
A1R98	EP21-10K .1%	RESISTOR 10K .1% 15PPM	07088	5-80374	266
A1R99	RC07GF512J	RESISTOR 5.1K 5% 1/4W	81349	5-10069	267
A1R100	RC42GF104J	RESISTOR 100K 5% 2W	81349	5-40015	268
A1R101	CIC 512	RESISTOR 8.9976M	16067	5-60614	269
A1R102	RN60C4991F	RESISTOR 4.99K 1% 1/8W	81349	5-60238	270
A1R103	CIC 512	RESISTOR 897.25K	16067	5-60614	271
A1R104	91A-500Ω	POTENTIOMETER 500Ω	73138	5-70220	272
A1R105	CIC 512	RESISTOR 89.725	16067	5-60614	273
A1R106	91A-50Ω	POTENTIOMETER 50Ω	73138	5-70201	274
A1R107	RC07GF913J	RESISTOR 91K 5% 1/4W	81349	5-10099	275
A1R108	RC20GF241J	RESISTOR 240Ω 5% 1/2W	81349	5-20120	276
A1R109	RC07GF222J	RESISTOR 2.2K 5% 1/4W	81349	5-10060	277
A1R110	CIC 512	RESISTOR 9.975K	16067	5-60614	278
A1R111	RC32GF330J	RESISTOR 33Ω 5% 1W	81349	5-30080	279
A1R112	RC07GF182J	RESISTOR 1.8K 5% 1/4W	81349	5-10058	280
A1R113	RC07GF182J	RESISTOR 1.8K 5% 1/4W	81349	5-10058	281
A1R114	RC32GF330J	RESISTOR 33Ω 5% 1W	81349	5-30080	282
A1R115	RC07GF100J	RESISTOR 10Ω 5% 1/4W	81349	5-10005	283
A1R116	RC07GF514J	RESISTOR 510K 5% 1/4W	81349	5-10116	284
A1R117	91A-1K	POTENTIOMETER 1K	73138	5-70204	285
A1R118	RC07GF862J	RESISTOR 6.8K 5% 1/4W	81349	5-10072	286
A1R119	RC07GF101J	RESISTOR 100Ω 5% 1/4W	81349	5-10029	287
A1R120	RC07GF100J	RESISTOR 10Ω 5% 1/4W	81349	5-10005	288

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1R121	RC07GF471J	RESISTOR 470Ω 5% 1/4W	81349	5-10045	289
A1R122	RC07GF106J	RESISTOR 10M 5% 1/4W	81349	5-10134	290
					291
					292
					293
					294
					295
					296
					297
A1S1	46206LF	SWITCH 115/230V	82389	2-40298	298
A1S2	8542-012	SWITCH, PUSH BUTTON	16067	2-40451	299
					300
					301
					302
A1T1	8542-010	TRANSFORMER, POWER	16067	7-10259	303
					304
					305
					306
A1Y1	CR-18A/U	CRYSTAL 1MHz	13454	3-30135	307
					308
					309
					310
	8542-206-7	SHIELD	16067	1-10429	311
	8542-208-7	HEATSINK	16067	2-10495	312
	DM 123	MICA WASHER TO-3	08289	3-30192	313
	MS9596-005	ANGLE BKT	18076	1-10502	314
	843	CABLE CLAMP	83330		315
	J-76115-00 1/8 THK	SPACER, DOG-BONE	71590		316
	FT-2-SM-11o4SL	TERMINAL, TEFLON	98291	2-50227	317
	1299B-1	TERMINAL	88245	2-50146	318
	129515	ANGLE BRACKET	73734	1-10167	319
	1591B	CHASSIS FASTENER	88245	2-10416	320
	6025D	HEATSINK	13103	2-10499	321
	8837	STANDOFF 8-32 x 5/8 LG	83330	2-10498	322
	4-40 x 5/16 LG	SCREW, PAN HEAD			323
	#4	WAHSER, INT. STAR			324

MODEL DMM 42 | CALICO P/N 8542-700 | ASSY R.D. A1

TITLE P.C. BOARD ASSEMBLY - DIGITAL/ANALOG | SHT 13 OF 14

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
	4-40	NUT			325
	6-32 x 7/16 LG	SCREW, PAN HEAD			326
	#6	WASHER, INT. STAR			327
	6-32	NUT			328
	8-32 x 3/8 LG	SCREW, PAN HEAD			329
	#8	WASHER, INT. STAR			330
					331
	10-32 x 3/16	SCREW, PAN HD			332
	#10	WASHER, INT STAR			333
	10-32	NUT			334
					335
					336
	THERMATE	SILICONE COMPOUND			337
	2169	FIBER WASHER	83330	2-10546	338
	10274	CRYSTAL PAD	0000W	2-10521	339
	158	TERMINAL	83330	2-50257	340
					341
					342
					343
					344
					345
					346
					347
					348
					349
					350
					351
					352
					353
					354
					355
					356
					357
					358
					359
					360

MODEL DMM 42 | CALICO P/N 8542-700 | ASSY R.D. A1

TITLE P.C. BOARD ASSEMBLY - DIGITAL/ANALOG | SHT 14 OF 14

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A2	8542-705-1	P.C. BOARD, DISPLAY	16067		1
	8542-705-7	P.C. BOARD, MECH	16067	1-00209	2
					3
					4
					5
					6
A2DS1	SP351	DISPLAY, POL. NUM.	07713	2-30042	7
A2DS2	SP353	DISPLAY, NUMERALS	07713	2-30063	8
A2DS3	LSL-3L	L.E.D.	00005	2-50212	9
A2DS4	LSL-3L	L.E.D.	00005	2-50212	10
A2DS5	LSL-3L	L.E.D.	00005	2-50212	11
A2DS6	LSL-3L	L.E.D.	00005	2-50212	12
A2DS7	LSL-3L	L.E.D.	00005	2-50212	13
A2DS8	LSL-3L	L.E.D.	00005	2-50212	14
A2DS9	LSL-3L	L.E.D.	00005	2-50212	15
A2D10	LSL-3L	L.E.D.	00005	2-50212	16
					17
					18
					19
					20
A2IC1	DD700	INTEGRATED CIRCUIT	07713	3-60055	21
A2IC2	DD700	INTEGRATED CIRCUIT	07713	3-60055	22
A2IC3	DD700	INTEGRATED CIRCUIT	07713	3-60055	23
A2IC4	DD700	INTEGRATED CIRCUIT	07713	3-60055	24
A2IC5	SN7441AN	INTEGRATED CIRCUIT	27014	3-60003	25
					26
					27
					28
					29
A2Q1	2N5550	TRANSISTOR	81349	3-30255	30
A2Q2	2N5550	TRANSISTOR	81349	3-30255	31
A2Q3	2N5550	TRANSISTOR	81349	3-30255	32
					33
					34
					35
					36

MODEL DMM 42 | CALICO P/N 8542-705 | ASSY REV. A2

TITLE P.C. BOARD ASSEMBLY - DISPLAY | SHT 4 OF 5

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A2R1	RC07GF222J	RESISTOR 2.2K 5% 1/4W	81349	5-10060	37
A2R2	RC07GF222J	RESISTOR 2.2K 5% 1/4W	81349	5-10060	38
A2R3	RC07GF222J	RESISTOR 2.2K 5% 1/4W	81349	5-10060	39
A2R4	RC07GF222J	RESISTOR 2.2K 5% 1/4W	81349	5-10060	40
A2R5	RC07GF222J	RESISTOR 2.2K 5% 1/4W	81349	5-10060	41
A2R6	RC07GF151J	RESISTOR 150Ω 5% 1/4W	81349	5-10033	42
A2R7	RC07GF683J	RESISTOR 68K 5% 1/4W	81349	5-10096	43
A2R8	RC07GF134J	RESISTOR 130K 5% 1/4W	81349	5-10103	44
A2R9	RC07GF114J	RESISTOR 110K 5% 1/4W	81349	5-10101	45
A2R10	RC07GF114J	RESISTOR 110K 5% 1/4W	81349	5-10101	46
A2R11	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-10076	47
A2R12	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-10076	48
A2R13	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-10076	49
A2R14	RC07GF185J	RESISTOR 1.8M 5% 1/4W	81349	5-10125	50
A2R15	RC07GF185J	RESISTOR 1.8M 5% 1/4W	81349	5-10125	51
A2R16	RC07GF185J	RESISTOR 1.8M 5% 1/4W	81349	5-10125	52
A2R17	RC07GF334J	RESISTOR 330K 5% 1/4W	81349	5-10112	53
A2R18	RC07GF334J	RESISTOR 330K 5% 1/4W	81349	5-10112	54
A2R19	RC07GF334J	RESISTOR 330K 5% 1/4W	81349	5-10112	55
A2R20	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-10076	56
A2R21	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-10076	57
A2R22	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-10076	58
A2R23	RC07GF103J	RESISTOR 10K 5% 1/4W	81349	5-10076	59
					60
					61
					62
					63
					64
					65
					66
					67
					68
					69
					70
					71
					72

MODEL DMM 42 | CALICO P/N 8542-705 | ASSY R.D. A2

TITLE P.C. BOARD ASSEMBLY - DISPLAY | SHT 5 OF 5

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A3	8542-701-1	P.C. BOARD ASSY	16067		1
	8542-701-7	P.C. BOARD MECH	16067	1-60205	2
		EYELET (SEE SHEET 3)			3
					4
					5
					6
A3C1	ZA2J504K	CAPACITOR .5μF 1KV	27556	6-10915	7
A3C2	561-013	CAPACITOR VAR. .8-4.5pF	72982	6-10909	8
A3C3	DM10-020D	CAPACITOR 2pF 500V	72136	6-10001	9
A3C4	DM10-020D	CAPACITOR 2pF 500V	72136	6-10001	10
A3C5	561-013	CAPACITOR VAR. .8-4.5pF	72982	6-10909	11
A3C6	DM10-020D	CAPACITOR 2pF 500V	72136	6-10001	12
A3C7	T362B685M035AS	CAPACITOR 6.8μF 35V	05397	6-10812	13
A3C8	T362B685M035AS	CAPACITOR 6.8μF 35V	05397	6-10812	14
A3C9	T362B336M010AS	CAPACITOR 33μF 10V	05397	6-10751	15
A3C10	T362B685M035AS	CAPACITOR 6.8μF 35V	05397	6-10812	16
A3C11	TG-S10	CAPACITOR .01μF 100V	56289	6-10759	17
A3C12	563-013	CAPACITOR VAR. .8-8.5pF	72982	6-10918	18
A3C13	CM05C180J03	CAPACITOR 18pF 500V	81349	6-10258	19
A3C14	HT10MA/550	CAPACITOR VAR. .5-50pF	73445	6-10919	20
A3C15	CM05F201J03	CAPACITOR 200pF 500V	81349	6-10282	21
A3C16	DM19-512F	CAPACITOR 5100pF 500V	72136	6-10516	22
A3C17	CM06F511J03	CAPACITOR 510pF 500V	81349	6-10046	23
A3C18	C280AE/A100K	CAPACITOR .1μF 250V	73445	6-10916	24
A3C19	CM05F101J03	CAPACITOR 100pF 500V	81349	6-10027	25
A3C20	C5A205J	CAPACITOR 2μF 50V	12406	6-10942	26
A3C21	C5A205J	CAPACITOR 2μF 50V	12406	6-10942	27
A3C22	C5A205J	CAPACITOR 2μF 50V	12406	6-10942	28
A3C23	T362B336M010AS	CAPACITOR 33μF 10V	05397	6-10751	29
A3C24	C5A205J	CAPACITOR 2μF 50V	12406	6-10942	30
A3C25	CM05E300J03	CAPACITOR 30pF 500V	81349	6-10263	31
A3C26	B1A104J	CAPACITOR .1μF 100V	12406	6-10902	32
A3C27	C280AE/A100K	CAPACITOR .1μF 250V	73445	6-10916	33
					34
					35
					36

MODEL DMM 42 | CALICO P/N 8542-701 | ASSY R.D. A3

TITLE P.C. BOARD ASSEMBLY - A.C. CONVERTER | SHT 4 OF 7

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A3CR1	1N4148	DIODE	25403	3-10227	37
A3CR2	1N4148	DIODE	25403	3-10227	38
A3CR3	1N4148	DIODE	25403	3-10227	39
A3CR4	1N4148	DIODE	25403	3-10227	40
A3CR5	1N4148	DIODE	25403	3-10227	41
A3CR6	1N4148	DIODE	25403	3-10227	42
A3CR7	1N4148	DIODE	25403	3-10227	43
A3CR8	1N4148	DIODE	25403	3-10227	44
A3CR9	1N4148	DIODE	25403	3-10227	45
A3CR10	1N4148	DIODE	25403	3-10227	46
A3CR11	FH1100	DIODE	07263	3-10212	47
A3CR12	FH1100	DIODE	07263	3-10212	48
					49
					50
					51
					52
A3IC1	LM318H	INTEGRATED CIRCUIT	27014	3-60033	53
A3IC2	LM301AH	INTEGRATED CIRCUIT	27014	3-60021	54
					55
					56
					57
					58
A3J8	1261-R-2	CONNECTOR, HOUSING	27264	4-10203	59
A3J9	1261-R-2	CONNECTOR, HOUSING	27264	4-10203	60
A3J10	1261-R-2	CONNECTOR, HOUSING	27264	4-10203	61
					62
					63
					64
					65
A3K1	R10E943-3	RELAY	24796	2-45130	66
A3K2	214-00003	RELAY 1 FORM A	31951	2-45126	67
A3K3	214-00003	RELAY 1 FORM A	31951	2-45126	68
A3K4	214-00008	RELAY 2 FORM A	31951	2-45127	69
					70
					71
					72

MODEL DMM 42 | CALICO P/N 8542-701 | ASSY R.D. A3

TITLE P.C. BOARD ASSEMBLY - A.C. CONVERTER | SHT 5 OF 7

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A3Q1	CIC 368	TRANSISTOR, F.E.T.	16067	3-30268	73
A3Q2	2N5172	TRANSISTOR	56289	3-30219	74
					75
					76
					77
					78
					79
					80
A3R1	A3AL14	RESISTOR 1M .1% 1W 25PPM	03888	5-80305	81
A3R2	3299W-1-502	POTENTIOMETER 5K	80294	5-70224	82
A3R3	PME65-274.9K-.1%	RESISTOR 274.9K .1% 25PPM	03888	5-80347	83
A3R4	RC07GF133J	RESISTOR 13K 5% 1/4W	81349	5-10079	84
A3R5	RN60D1622F	RESISTOR 16.2K 1%	81349	5-60094	85
A3R6	RN60D4121F	RESISTOR 4.12K 1%	81349	5-60339	86
A3R7	RC07GF101J	RESISTOR 100Ω 5% 1/4W	81349	5-10029	87
A3R8	RC07GF472J	RESISTOR 4.7K 5% 1/4W	81349	5-10068	88
A3R9	PME65-30.41K-.1%	RESISTOR 30.41K .1% 25PPM	03888	5-80313	89
A3R10	PME65-2.637K-.1%	RESISTOR 2.637K .1% 25PPM	03888	5-80312	90
A3R11	PME65-139.7Ω-.1%	RESISTOR 139.7Ω .1% 25PPM	03888	5-80310	91
A3R12	RC07GF513J	RESISTOR 51K 5% 1/4W	81349	5-10093	92
A3R13	3299W-1-501	POTENTIOMETER 500Ω	80294	5-70213	93
A3R14	RN60C49R9F	RESISTOR 49.9Ω 1%	81349	5-60463	94
A3R15	3299W-1-101	POTENTIOMETER 100Ω	80294	5-70225	95
A3R16	RC07GF104J	RESISTOR 100K 5% 1/4W	81349	5-10100	96
A3R17	RC07GF513J	RESISTOR 51K 5% 1/4W	81349	5-10093	97
A3R18	PME65-561.1Ω-.1%	RESISTOR 561.1Ω .1% 25PPM	03888	5-80309	98
A3R19	PME65-561.1Ω-.1%	RESISTOR 561.1Ω .1% 25PPM	03888	5-80309	99
A3R20	PME65-139.7Ω-.1%	RESISTOR 139.7Ω .1% 25PPM	03888	5-80310	100
A3R21	PME65-15.4K-.1%	RESISTOR 15.4K .1% 25PPM	03888	5-80306	101
A3R22	PME65-15.4K-.1%	RESISTOR 15.4K .1% 25PPM	03888	5-80306	102
A3R23	PME65-15.4K-.1%	RESISTOR 15.4K .1% 25PPM	03888	5-80306	103
A3R24	PME65-30K-.1%	RESISTOR 30K .1% 25PPM	03888	5-80307	104
A3R25	PME65-15.4K-.1%	RESISTOR 15.4K .1% 25PPM	03888	5-80306	105
A3R26	PME65-30K-.1%	RESISTOR 30K .1% 25PPM	03888	5-80307	106
A3R27	RC07GF183J	RESISTOR 18K 5% 1/4W	81349	5-10082	107
A3R28	RC07GF180J	RESISTOR 18Ω 5% 1/4W	81349	5-10011	108

MODEL DMM 42 | CALICO P/N 8542-701 | ASSY R.D. A3

TITLE P.C. BOARD ASSEMBLY - A.C. CONVERTER | SHT 6 OF 7

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A3R29	3299W-1-203	POTENTIOMETER 20K	80294	5-70226	109
A3R30	RN60C1470F	RESISTOR 147Ω 1%	81349	5-60479	110
A3R31	3299W-1-201	POTENTIOMETER 200Ω	80294	5-70228	111
A3R32	PME65-25K-.1%	RESISTOR 25K .1% 25PPM	03888	5-80308	112
					113
					114
					115
					116
	8542-202-7	SHIELD, TOP	16067	1-10425	117
	8542-204-7	SHIELD, BOTTOM	16067	1-10427	118
	8542-209-7	SHIELD, GUARD	16067	1-10432	119
					120
					121
					122
	5201-0223	PIN CONNECTOR	91662	4-10217	123
	02-09-2132	PIN, MALE	27264	4-10204	124
	02-09-1132	PIN, FEMALE	27264	4-10205	125
	RST-2-SM-1160SL	TERMINAL, TEFLON	98291	2-50228	126
	FT-2-SM-1164SL	TERMINAL, TEFLON	98291	2-50227	127
					128
					129
	8428	STANDOFF 6-32 x 1 1/4 LG	83330	2-10090	130
	8248	STANDOFF 6-32 x 1/4 LG	83330	2-10496	131
	#6	WASHER, INT. STAR			132
	6-32 x 3/16 LG	SCREW, PAN HEAD			133
					134
					135
					136
					137
					138
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					142
					143
					144

MODEL DMM 42 | CALICO P/N 8542-701 | ASSY R.D. A3

TITLE P.C. BOARD ASSEMBLY - A.C. CONVERTER | SHT 7 OF 7

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A4	8542-702-1	P.C. BOARD ASSY	16067		1
	8542-702-7	P.C. BOARD MECH	16067	1-60206	2
		EYELET (SEE SHEET 3)			3
					4
					5
					6
A4C1	T362B106M025AS	CAPACITOR 10μF 25V	05397	6-10738	7
A4C2	T362B106M025AS	CAPACITOR 10μF 25V	05397	6-10738	8
A4C3	CM05E300J03	CAPACITOR 30pF 500V	81349	6-10263	9
A4C4	SX210	CAPACITOR 1000pF 600V	90201	6-10910	10
					11
					12
					13
A4CR1	1N4148	DIODE	25403	3-10227	14
A4CR2	1N5246A	DIODE, ZENER 16V	04713	3-10145	15
A4CR3	1N5246A	DIODE, ZENER 16V	04713	3-10145	16
A4CR4	1N4148	DIODE	25403	3-10227	17
A4CR5	1N4148	DIODE	25403	3-10227	18
A4CR6	1N4148	DIODE	25403	3-10227	19
A4CR7	1N4148	DIODE	25403	3-10227	20
A4CR8	1N4148	DIODE	25403	3-10227	21
A4CR9	1N4148	DIODE	25403	3-10227	22
A4CR10	1N5237A	DIODE, ZENER 8.2V	81349	3-10246	23
A4CR11	CIC 725	DIODE, ZENER and RESISTOR	16067	3-10230	24
A4CR12	1N4004	DIODE	04713	3-10062	25
A4CR13	1N4148	DIODE	25403	3-10227	26
A4CR14	1N4148	DIODE	25403	3-10227	27
A4CR15	1N4148	DIODE	25403	3-10227	28
A4CR16	1N4148	DIODE	25403	3-10227	29
A4CR17	1N4148	DIODE	25403	3-10227	30
					31
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					33
					34
					35
					36

MODEL DMM 42 | CALICO P/N 8542-702 | ASSY R.D. A4

TITLE P.C. BOARD ASSEMBLY - OHMS CONVERTER | SHT 4 OF 7

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A4IC1	CIC 232	INTEGRATED CIRCUIT	16067	3-60136	37
A4IC2	LM301AN	INTEGRATED CIRCUIT	27014	3-60029	38
					39
					40
					41
					42
A4J11	1261-R-2	CONNECTOR, HOUSING	27264	4-10203	43
A4J12	1261-R-2	CONNECTOR, HOUSING	27264	4-10203	44
A4J13	1261-R-2	CONNECTOR, HOUSING	27264	4-10203	45
					46
					47
					48
					49
A4K1	R10-E2-Z2-S200	RELAY	24796	2-45129	50
A4K2	R10-E2-Z2-S200	RELAY	24796	2-45129	51
A4K3	214-00003	RELAY 1 FORM A 6V	31951	2-45126	52
A4K4	214-00003	RELAY 1 FORM A 6V	31951	2-45126	53
A4K5	214-00003	RELAY 1 FORM A 6V	31951	2-45126	54
A4K6	214-00003	RELAY 1 FORM A 6V	31951	2-45126	55
A4K7	R10-E2-Z2-S200	RELAY	24796	2-45129	56
					57
					58
					59
					60
A4Q1	T1P 29	TRANSISTOR	01295	3-30241	61
A4Q2	T1P 30	TRANSISTOR	01295	3-30250	62
A4Q3	CIC 365	TRANSISTOR F.E.T.	16067	3-30245	63
A4Q4	CIC 365	TRANSISTOR F.E.T.	16067	3-30245	64
A4Q5	2N5226	TRANSISTOR	81349	3-30239	65
A4Q6	MJE 3440	TRANSISTOR	04713	3-30254	66
					67
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					72

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CALICO P/N 8542-702

ASSY R.D. A4

TITLE P.C. BOARD ASSEMBLY - OHMS CONVERTER

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CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A4R1	RC20GF470J	RESISTOR 47Ω 5% 1/2W	81349	5-20013	73
A4R2	RC07GF222J	RESISTOR 2.2K 5% 1/4W	81349	5-10060	74
A4R3	RC07GF222J	RESISTOR 2.2K 5% 1/4W	81349	5-10060	75
A4R4	RC20GF470J	RESISTOR 47Ω 5% 1/2W	81349	5-20013	76
A4R5	RN60C4991F	RESISTOR 4.99K 1%	81349	5-60238	77
A4R6	EP-21	RESISTOR 102Ω .1%	07088	5-80289	78
A4R7	3299W-1-501	POTENTIOMETER 500Ω	80294	5-70213	79
A4R8	EP-21	RESISTOR 998.5Ω .1%	07088	5-80290	80
A4R9	RN60D10R0F	RESISTOR 10Ω 1%	81349	5-60455	81
A4R10	91A-10Ω	POTENTIOMETER 10Ω	73138	5-70202	82
A4R11	EP-21	RESISTOR 9.985K .1%	07088	5-80291	83
A4R12	91A-50Ω	POTENTIOMETER 50Ω	73138	5-70201	84
A4R13	EP-21	RESISTOR 100.76K .1%	07088	5-80292	85
A4R14	91A-500Ω	POTENTIOMETER 500Ω	73138	5-70220	86
A4R15	EP-21	RESISTOR 1.1086M .1%	07088	5-80293	87
A4R16	91A-5K	POTENTIOMETER 5K	73138	5-70219	88
A4R17	91A-50Ω	POTENTIOMETER 50Ω	73138	5-70201	89
A4R18	EP-21	RESISTOR 870Ω .1%	07088	5-80295	90
A4R19	91A-10Ω	POTENTIOMETER 10Ω	73138	5-70202	91
A4R20	EP-21	RESISTOR 95Ω .1%	07088	5-80294	92
A4R21	PME-80-25PPM 9.95M	.25% RESISTOR 9.95M .25%	03888	5-80297	93
A4R22	91A-100K	POTENTIOMETER 100K	73138	5-70221	94
A4R23	RC07GF334J	RESISTOR 330K 5% 1/4W	81349	5-10112	85
A4R24	RC07GF223J	RESISTOR 22K 5% 1/4W	81349	5-10084	96
A4R25	RC07GF430J	RESISTOR 43Ω 5% 1/4W	81349	5-10020	97
A4R26	RC07GF512J	RESISTOR 5.1K 5% 1/4W	81349	5-10069	98
A4R27	EP-21	RESISTOR 5.325K .1%	07088	5-80296	99
A4R28	CIC 725	RESISTOR - part of CIC 725	16067	3-10230	100
A4R29	RC07GF162J	RESISTOR 1.6K 5% 1/4W	81349	5-10158	101
A4R30	RN60C4531F	RESISTOR 4.53K 1%	81349	5-60570	102
A4R31	91A-500Ω	POTENTIOMETER 500Ω	73138	5-70220	103
A4R32	RN60D2491F	RESISTOR 2.49K 1%	81349	5-60363	104
A4R33	RC07GF512J	RESISTOR 5.1K 5% 1/4W	81349	5-10069	105
A4R34	RC07GF223J	RESISTOR 22K 5% 1/4W	81349	5-10084	106
					107
					108

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TITLE P.C. BOARD ASSEMBLY - OHMS CONVERTER | SHT 6 OF 7

CALIFORNIA INSTRUMENTS CO.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
					109
					110
					111
					112
					113
					114
	8542-203-7	SHIELD, TOP	16067	1-10426	115
	8542-205-7	SHIELD, BOTTOM	16067	1-10428	116
	RG179B/U	WIRE, SHLD, TEF. INS.	81349		117
	#22 AWG INS.	WIRE, BLACK			118
					119
					120
					121
					122
	R4148	RING LUG, 22/16-8 STUD	14726		123
	PA2-1CB	HEATSINK	98978	2-10497	124
	FT-2-SM-1164SL	TERMINAL, TEFLON	98291	2-50227	125
	2010B-1	TERMINAL	88245	2-50076	126
	02-09-2132	PIN, MALE	27264	4-10204	127
	02-09-1132	PIN, FEMALE	27264	4-10205	128
	8428	STANDOFF, 6-32 x 1 1/4 LG	83330	2-10090	129
	8248	STANDOFF, 6-32 x 1/4 LG	83330	2-10496	130
	6-32 x 1/4" LG	SCREW, PAN HEAD			131
	#6	WASHER, INT.-STAR			132
	4-40 x 1/2" LG	SCREW, PAN HEAD			133
	#4	WASHER, INT.-STAR			134
	4-40	NUT			135
					136
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MODEL DMM 42

CALICO P/N 8542-702

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TITLE P.C. BOARD ASSEMBLY - OHMS CONVERTER

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APPENDIX A

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbook H4-1 and its latest supplement. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbook.

0000A	ElectriCord	Westfield, PA
0000B	Tech. Prod. Sales	Sorrento Valley, CA
0000C	Jackson Bros.	Waduon, Surrey, England
0000D	Chicago Std. Transformer Co.	Chicago, IL
0000E	Use Code #08289	
0000F	Colvern	Santa Monica, CA
0000G	Use Code #30983	
0000H	Mial of Italy c/o Q.C. Components	Los Angeles, CA
0000I	Use Code #50522	
0000J	Use Code #34333	
0000K	Elma	Schweiz, Germany
0000L	Use Code #32293	
0000M	Use Code #16950	
0000N	Use Code #15912	
0000R	American Handle	Philadelphia, PA
0000S	OPCDA	Edison, NJ
0000T	Use Code #31743	
0000U	Use Code #32293	
0000V	Falmat	Los Angeles, CA
0000W	Milton Ross Co.	Southampton, PA
0000X	Use Code #52072	
0000Y	Use Code #29990	
00141	Pic Design Corp.	E. Rockaway, NY
00194	Walsco Electronics Corporation	Los Angeles, CA
00544	Metal-Cal Div., Avery Prod. Corp.	Inglewood, CA
00656	Aerovox Corporation	New Bedford, MA
00779	AMP, Inc.	Harrisburg, PA
00853	Sangamo Electric Company	Pickens, SC
00866	Goe Eng. Co., Inc.	City of Industry, CA
01121	Allen-Bradley Company	Milwaukee, WI
01179	Ajax Magnethermic Corp.	NE Warren, OH
01255	Litton Industries, Inc.	Beverly Hills, CA
01281	T P W Semiconductors, Inc.	Lawndale, CA
01295	Texas Instruments, Inc.	Dallas, TX
02111	Spectrol Electronics	City of Industry, CA
02114	Ferroxcube Corp.	Saugerties, NY
02335	Fairchild Controls Corp.	Hicksville, LI, NY
02660	Amphenol Corporation	Broadview, IL
02799	Use Code #72136	
03507	General Electric Company	Syracuse, NY
03508	General Electric Company	Syracuse, NY
03516	General Electric Company	Somersworth, NH
03797	Eldema Corporation	Compton, CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, NJ
03911	Clairex Corporation	New York, NY
04009	Arrow-Hart and Hegeman Elec. Co.	Hartford, CT
04062	Use Code #72136	
04713	Motorola Semiconductor Prod., Inc.	Phoenix, AZ
04963	3-M	St. Paul, MN
05236	Jonathan Mfg. Co.	Fullerton, CA
05276	Pomona Electronics Co., Inc.	Pomona, CA
05347	Ultronics	Grand Junction, CO
05397	Kemet, Union Carbide Corp.	Cleveland, OH
05820	Wakefield Engineering, Inc.	Wakefield, MA
06046	Dixson Meter	Grand Junction, CO
06184	Conelco Components	San Bernadino, CA
06223	Kooltronic Fan Company	Princeton, NJ
06229	Electrovert, Incorporated	Mt. Vernon, NY
06383	Panduit Corp.	Tinley Park, IL
06514	Stantron, Wyco Metal Products	N. Hollywood, CA
06540	Amathom Elect. Hardward	New Rochelle, NY
06682	Magnetic Shield Div.	Chicago, IL
06776	Robinson, Nugent, Inc.	New Albany, IN
06915	Richco Plastics, Co.	Chicago, IL
07088	Kelvin Electric Company	Van Nuys, CA
07115	Use Code #14674	
07256	Silicon Transistor Corp.	Garden City, NY
07263	Fairchild Camera and Instr. Corp.	Mt. View, CA
07387	Birtcher Corporation	Los Angeles, CA
07556	Unitrack Calabro Plastics	Upper Darby, PA
07633	Epoxy Prod. Co. Div. of Allied Prod. Corp.	New Haven, CT
07713	Sperry Rand Corporation	Norwalk, CT
07716	I R C Incorporated	Burrington, IA
07910	Continental Devices	Hawthorne, CA
08065	Accurate Rubber and Plastics Co.	San Diego, CA
08261	Spectra Strip	Garden Grove, CA
08289	Blinn-Delbert Co., Inc.	Pomona, CA
08594	Eimac Div. of Varian Associates	Salt Lake, UT
08718	Use Code #71468	
08730	Vemaline Products Co.	Franklin Lakes, NJ
09026	Babcock Electronics Corp.	Costa Mesa, CA
09145	Atohm, Technical Industries, Inc.	Burbank, CA
09353	C and K Components, Inc.	Newton, MA
11432	Diamond Metal Sales	Gardena, CA
11815	Cherry Rivet Div., Townsend Co.	Santa Ana, CA
12020	Ovenaire, Incorporated	Charlottesville, VA
12143	Bendix Corporation	Santa Ana, CA
12405	Hysol Corporation	El Monte, CA
12406	Elpac, Incorporated	Fullerton, CA
12463	Omtronics Mfg., Incorporated	Omaha, NE
12673	Wesco Electrical Co.	Greenfield, MA
12697	Clarostat Mfg. Co., Incorporated	Dover, NH
13103	Thermalloy Company	Dallas, TX
13454	Texas Crystals	River Grove, IL
13571	Electronic Research	Overland Park, KS
13919	Burr-Brown Research Corp.	Tucson, AS
14099	Semtech Corporation	Newbury Park, CA
14193	Cal-R Inc.	Santa Monica, CA
14655	Cornell-Dubilier Elect. Corp.	Newark, NJ
14674	Corning Glass Works	Corning, NY
14726	Hollingsworth Co.	Phoenixville, PA
14752	Electro Cube, Incorporated	San Gabriel, CA
14907	Cramer Div. of Conrac	Old Saybrook, CT
15112	Electra Scientific Corporation	Fullerton, CA
15636	Elec-trol	Northridge, CA
15801	Fenwall Electronics	Framingham, MA
15818	Amelco, Teledyne, Incorporated	Mt. View, CA
15909	Use Code #17870	
15912	Ansley	Los Angeles, CA
16067	California Instruments Company	San Diego, CA
16758	Delco Radio Div., General Motors	Kokomo, IN
16795	Bristol Electronics Inc.	Bedford, MA
16902	Simpson Instruments, Inc.	Escondido, CA
16950	Precision Dynamics Corp.	Burbank, CA
17745	Angstrohm Precision, Inc.	Van Nuys, CA
17838	Mektron, California General, Inc.	Chula Vista, CA
17870	Daven Div., Thomas A. Edison	Manchester, NH
18076	Umpco	City of Industry, CA
18121	Wilshire Foam Products, Inc.	Gardena, CA
18178	Vactec Inc.	Maryland Heights, MO
18324	Signatics	Sunnyvale, CA
18612	Vishay Instruments Inc.	Malvern, PA
18677	Scambe Mfg. Co.	Monterey Park, CA
18702	Ducommun Metals and Supply Co.	Los Angeles, CA
18722	R C A	Mountaintop, PA
19080	The Robinson Company	Hawthorne, CA
19781	Potter Company	Sun Valley, CA
20857	South Bay Cable Corp.	Gardena, CA
21270	Behr-Manning	Watervliet, NY
21604	Buckeye Stamping Company	Columbus, OH
22045	Jordan Elect.	Van Nuys, CA
22599	Elastic Stop Nut Corporation	Van Nuys, CA
23039	Deccofelt Products Company	Glendora, CA
23050	Product Components Corp.	Hastings-on-Hudson, NY
23095	Astec Electronics Inc.	Anaheim, CA
23783	British Radio Electric Ltd.	Washington, DC
23936	Pamotor, Incorporated	San Francisco, CA
24011	E C C	Burlington, MA
24655	General Radio	Concord, MA
24796	Parelco Inc.	Paramount, CA
24931	Specialty Connector Co., Inc.	Indianapolis, IN
25403	Amperex (Diodes)	Slaterville, RI
25684	Victoreen Instrument Co., Inc.	Oak Lawn, IL
25706	Daburn Electronics and Cable Corp.	New York, NY
26528	Lamcor, Incorporated	Anaheim, CA
26533	Use Code #98376	
27014	National Semi-Conductor Corp.	Santa Clara, CA
27191	Cutler-Hammer, Inc.	Milwaukee, WI
27264	Molex	Downers Grove, IL
27556	IMB Electronic Products	Santa Fe Springs, CA
27683	Varo, Incorporated	St. Garland, TX
28480	Hewlett-Packard Co.	Palo Alto, CA
28520	Heyman Mfg. Company (Heyco)	Kenilworth, NJ
30086	I-T-E Circuit Breaker Co.	Philadelphia, PA
30817	Instrument Specialties Co.	Little Falls, NJ
30897	Dorann Co.	Sylmar, CA
30983	Electra/Midland (Mepco/Electra)	San Diego, CA
31743	Elpower	Santa Ana, CA
31951	Tririge Inc.	Pittsburgh, PA
32293	Intersil	Cupertino, CA
34333	Silicon General	Westminister, CA
35929	Constanta	Quebec, Canada
42190	Muter Company	Chicago, IL
44655	Ohmite Manufacturing Company	Skokie, IL
45722	Parker-Kalon	Clifton, NJ
46384	Penn. Eng. and Mfg. Corp.	Doylestown, PA
49956	Raytheon Co.	Lexington, MA
50522	Monsanto, Electronic Special Products	Cupertino, CA
51705	ICO/Rally	Palo Alto, CA
52072	Circuit Assembly Corp.	Costa Mesa, CA
53209	W. H. Brady Co.	Milwaukee, WI
56289	Sprague Electric Company	North Adams, MA
57771	Stimson	Bayport, NY
58474	Superior Electric Company	Bristol, CT
59730	Thomas and Betts Company	Elizabeth, NJ
60741	Triplett Electrical Instrument Co.	Bluffton, OH
63743	Ward Leonard Electric Co.	Mt. Vernon, NY
70318	Allmetal Screw Prod. Co.	Garden City, NY
70903	Belden Manufacturing Co.	Chicago, IL
71002	Birnbach Radio Company, Inc.	New York, NY
71218	Bud Radio	Willoughby, OH
71279	Cambridge Thermionic Corp.	Cambridge, MA
71400	Bussman Mfg. Div., McGraw-Edison Co.	St. Louis, MO
71450	CTS Corporation	Elkhart, IN
71468	ITT Cannon Electric, Inc.	Los Angeles, CA
71590	Centralab Div., Globe-Union, Inc.	Milwaukee, WI
71744	Chicago Miniature Lampworks	Chicago, IL
71785	Cinch Manufacturing Company	Chicago, IL
72136	Elmenco (Electro Motive)	Willimantic, CT
72259	Nytronics, Incorporated	Pelham Manor, NY
72619	Dialight Corporation	Brooklyn, NY
72699	General Instruments	Newark, NJ
72982	Erie Technological Products, Inc.	Erie, PA
73138	Beckman Instruments, Inc.	Fullerton, CA
73445	Amperex (Capacitors)	Long Island, NY
73559	Carling Electric, Inc.	West Hartford, CT
73734	Federal Screw Products, Inc.	Chicago, IL
73899	J F D Electronics Company	Brooklyn, NY
73949	Guardian Electric Mfg. Co.	Chicago, IL
73957	Groov-Pin Corporation	Ridgefield, NJ
74193	Heinemann Electric Company	Trenton, NJ
74276	Signalite, Incorporated	Neptune, NJ
74542	Hoyt Electrical Instrument Works	Penacook, NH
74545	Harvey Hubbel, Inc.	Bridgeport, CT
74970	E. F. Johnson Company	Waseca, MN
75382	Kulka Electric Corporation	Mt. Vernon, NY
75915	Littlefuse, Incorporated	Des Plaines, IL
75987	Use Code #95987	
76055	Mallory Controls	Frankfort, IN
76348	Miller Products Company	New York, NY
76385	Minor Rubber Co.	Bloomfield, NJ
76493	J. W. Miller Company	Los Angeles, CA
76854	Oak Manufacturing Company	Crystal Lake, IL
77342	Potter and Brumfield Div., Amer. Machine and Foundry Company	E. Princeton, IN
77638	General Instruments	Brooklyn, NY
77969	Rubber Craft Corp. of California	Torrance, CA
78189	Shakeproof Div., Illoms Tool Works	Chicago, IL
78299	Struthers-Dunn, Incorporated	Pitman, NJ
78488	Stackpole Carbon Company	St. Marys, PA
78526	Stanwyck Winding Company, Inc.	Newburgh, NY
78553	Tinnerman Products, Inc.	Cleveland, OH
78947	Ucinite Company	Newtonville, MA
79130	Johns-Manville Products Corp.	Chicago, IL
79727	Continental-Wirt Electronics Corp.	Warminister, PA
79963	Zierick Mfg. Corporation	New Rochelle, NY
80031	Mepco/Electra	Morristown, NJ
80112	G. C. Electronics Company	Los Angeles, CA
80223	United Transformer Co.	New York, NY
80294	Bourns, Incorporated	Riverside, CA
80368	Sylvania Electric Products, Inc.	New York, NY
80583	Hammarlund Mfg. Co.	Red Bank, NJ
81073	Grayhill, Incorporated	La Grange, IL
81095	Triad Transformer Corp.	Venice, CA
81312	Winchester Electronics	Oakville, CT
81349	Military Spec., Standardization Division Directorate of Logistic Services DSA	
82104	Standard Grigsby	Aurora, IL
82389	Switchcraft, Incorporated	Chicago, IL
82877	Rotron Manufacturing Co., Inc.	Woodstock, NY
82893	Vector Electronics Inc.	Sylmar, CA
83058	Car Fastener Company	Cambridge, MA
83125	Nytronics Inc. Cap. Division	Darlington, SC
83324	Rosan, Incorporated	Newport Beach, CA
83330	Herman H. Smith, Inc.	Brooklyn, NY
83594	Burroughs Corporation	Plainfield, NJ
83701	Electronic Devices, Incorporated	Yonkers, NY
83827	Resistors Inc.	Chicago, IL
84171	Arco Electronics, Inc.	Great Neck, NY
86684	R C A	Harrison, NJ
86928	Seastrom Mfg. Co.	Glendale, CA
87034	Marco-Oak Industries	Anaheim, CA
88026	Use Code #27191	
88245	Useco Div., Litton Industries	Van Nuys, CA
90201	Mallory Capacitor Company	Indianapolis, IN
91459	Alcon Metal Prod. Inc.	Chicago, IL
91506	Augat	Attlebord, MA
91637	Dale Electronics, Inc.	Columbus, NE
91662	Elco Corporation	Willow Grove, PA
91812	Janco Corporation	Burbank, CA
91833	Keystone Electronics Corp.	New York, NY
91929	Micro Switch Div., Honeywell, Inc.	Freeport, IL
92194	Alpha Wire Corporation	Elizabeth, NJ
92219	Waldom Electronics, Inc.	Chicago, IL
93332	Sylvania Electric Products, Inc.	Woburn, MA
94222	Southco, Incorporated	Lester, PA
95146	Alco Electronics Products	Lawrence, MA
95303	R C A	Cincinnati, OH
95416	Use Code #95146	
95987	Weckesser Company, Inc.	Chicago, IL
96682	Genisco, Incorporated	Compton, CA
96733	San Fernando Electric Mfg. Co.	San Fernando, CA
97525	Electronic Engineering Co.	Santa Ana, CA
97918	Linemaster Switch Corp.	Woodstock, CT
97954	U.S. Components, Incorporated	Bronx, NY
98159	Rubber Teck, Incorporated	Gardena, CA
98278	Microdot, Incorporated (Lerco)	S. Pasadena, CA
98291	Sealectro Corp.	Mamaroneck, NY
98376	Zero Mfg. Co. (West)	Burbank, CA
98978	IERC	Burbank, CA
99028	Globe	Gardena, CA
99378	Atlee Corp.	Woburn, MA
99392	STM Corporation	Oakland, CA
99515	Marshall Industries	Monrovia, CA
99517	Vacco Industries	El Monte, CA
99742	Permacel Div., Johnson and Johnson	New Brunswick, NJ
99743	I M C	Maywood, CA
99800	Delevan Electronics Corporation	Aurora, NY
*29990	American Technical Ceramics	Huntington Station, NY

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS COMPANY a division of AIKEN INDUSTRIES INC. warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS COMPANY will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned to the Company freight prepaid, and when examination reveals that the fault has not occurred because of misuse or abnormal conditions of operation. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS COMPANY will submit an estimate for such charges before commencing repair if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS COMPANY or its local representative, giving full details of the difficulty, and including the model number and serial number. On receipt of this information, service data or shipping instructions will be furnished. If shipment is indicated, forward the instrument, freight prepaid, to the authorized repair station indicated in the instruction. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. CALIFORNIA INSTRUMENTS COMPANY will advise the disposition to be made of the equipment and arrange for repair or replacement. Please include model number and serial number when referring to the instrument.

MP MASTER
MA28083